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General Flow Passage: A Computer Program
To Calculate Aerothermal Performance of an
Arbitrary Flow Passage of Fixed Geometry

S. C. Skirvin

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General Flow Passage: A Computer Program To
Calculate Aerothermal Performance of an
Arbitrary Flow Passage of Fixed Geometry

S. C. Skirvin

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GENERAL FLOW PASSAGE PROGRAM

ABSTRACT

The General Flow Passage computer program calculates the one-dimensional aerothermal performance of a compressible flow passage of arbitrary geometry. The program computes overall temperature and pressure levels as well as local axial pressure and surface temperatures. It will accomodate non-frictional pressure loss coefficients at axial locations as well as at entrance and exit. Both laminar and turbulent flow are treated and internal expansion and contraction losses can be computed by the program. Almost any likely combination of flow and temperature data is acceptable as input data, such as maximum surface temperature or pressure drop. Heat transfer "boundary conditions" are tailored for nuclear heat transfer problems, but not irremediably so.

ACKNOWLEDGEMENTS

The capabilities built into the General Flow Passage program satisfy design calculation requirements which represent the composite experience of many aerothermal designers who have participated in the Aircraft Nuclear Propulsion Project at the General Electric Company. Acknowledgement is made of the advice and information supplied by these people.

In particular, acknowledgement is made of the efforts of J. E. Stankevicz who contributed a number of utility subroutines and participated in check-out and the contributions of R. R. Jordan in the preparation of the present report.

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I INTRODUCTION

The General Flow Passage program (hereafter referred to by the initials "GFP") is a considerably extended growth version of an earlier ANP Department program, the Off-Design Program (reference 2). Both programs utilize the same one-dimensional compressible flow loss analysis as applied to a single flow passage, but GFP accepts a much greater variety of input data and, it is hoped, is much simpler to use.

The Off-Design program was originally conceived for the purpose of providing a fast, convenient method to calculate the off-design-point performance of nuclear reactor cores. It proved to be quite successful for that purpose and, further, has proven to be a real workhorse program for compressible flow calculations for almost any kind of flow passage. Applications have included preliminary sizing and parametric performance calculations for nuclear reactor cores, shield coolant flow determination, analysis of test data, calculation of control rod coolant flow, and many similar tasks.

The shortcomings of the Off-Design program were that; 1) the preparation of the input data was more tedious than necessary, 2) there was no provision for the insertion of non-frictional pressure losses along the length of the flow passage, 3) there was no provision for parametric calculations whereby one or more of the flow variables could be systematically varied by a single record of input data, 4) no sort of summary printout for a group of cases computed during one computer run could be obtained, 5) only fully developed turbulent flow was treated, and 6) only the mass flow, inlet and exit total temperatures, and the inlet total pressure could be specified as input flow and temperature data. The effect of the last restriction was that it proved to be necessary to plot the results of Off-Design cases when it was desired to have a specified exit total or static pressure or a specified maximum surface temperature. By such graphs, the necessary value of the inlet pressure, mass flow, or inlet or exit temperature could be determined.

The GFP program has successfully overcome all of these shortcomings and, hence, represents a valuable tool for the aerothermal designer. It is naturally formulated in terms of the boundary conditions ordinarily used by the nuclear heat transfer designer, but there is no major analytical or logical difficulty in the way of revising the program to accept other types of boundary conditions. This matter is discussed in the Programmer and Analyst Comments section of the present report.

The present report contains a complete listing to the Fortran source deck together with certain SAP-coded subroutines which are not generally available.

II STATUS OF PROGRAM

ANP 7090 DIGITAL PROGRAM

No. 663

<u>Title</u>	<u>Engineer</u>	<u>Unit</u>
General Flow Passage Program (GFP)	S. C. Skirvin (Anal. and Coding)	Fluid Mech.

<u>Computer</u>	<u>Status</u>	<u>Category</u>
IBM 7090 32K memory	Production (very little production useage)	Thermodynamics

SS2 up for input from logical 2, SS2 down for card input. SS3 up for output on logical 3, SS3 down for output on-line.

Abstract

Calculates one-dimensional aerothermal performance of a compressible flow passage of arbitrary geometry. Computes overall temperature and pressure levels as well as local axial and surface temperatures. It will accomodate non-frictional pressure loss coefficients at axial locations as well as at entrance and exit. Both laminar and turbulent flow are treated and internal expansion and contraction losses can be computed by the program. Almost any likely combination of flow and temperature data is acceptable as input data, such as maximum surface temperature or pressure drop. Heat transfer "boundary conditions" are tailored for nuclear heat transfer problems.

References

Skirvin, S. C., "General Flow Passage: A Computer Program to Calculate Aerothermal Performance of an Arbitrary Passage of Fixed Geometry (ANP 663)" GE ANPD APEX 664, 8/61

Additional Remarks

Program is on file with:

Communications Specialist
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Cincinnati 15, Ohio

III MATHEMATICAL AND LOGICAL ANALYSIS

As was noted in the Introduction, the GFP program utilizes the same compressible flow loss analysis as did the Off-Design program described in reference 2. The pertinent equations will be described below, for the sake of completeness.

A considerably different analysis was employed for the calculation of surface temperature in GFP because the iterative method used in the Off-Design program proved to be unstable when direct thermal property values were used. (The Off-Design program utilized air properties implicitly expressed in the turbulent Nusselt Number correlation as exponential functions of temperature.) A numerical root-finding technique was used instead in GFP.

The same root-finding technique is used in more general form in the iterations which enable the GFP program to calculate, say, the weight flow required to produce a specified maximum surface temperature even though the latter is a function of the former.

In addition to the above major items, sufficient explanatory material is provided to answer most, if not all, of the questions about the contents of the GFP program which might arise.

III.1 Compressible Flow Loss Analysis

The stage exit bulk (total) temperature for the n-th stage is computed from the power profile by

$$T_{ex,n} = T_H(\phi_{ex,n} \Delta H + H_{in}) \quad (1)$$

where $T_H(\)$ is the temperature function of enthalpy and the total enthalpy increase, ΔH , is computed from

$$\Delta H = H_T(T_{ex}) - H_{in} \quad (2)$$

$H_T(\)$ is the enthalpy function of temperature.

For the n-th stage of finite, non-zero length ΔL_n , the pressure drop due to friction and heat addition can be expressed, following reference 6, as

$$P_{ex,n} = P_{in,n} e^{-\frac{8}{\pi} M_{av,n}^2 \left(L_n \times \frac{T_{ex,n}}{T_{in,n}} + \frac{4 f_n \Delta L_n}{D_{h,n}} \right)} \quad (3)$$

which is an approximate, integrated form of a differential equation in the reference cited. The average Mach number over the length ΔL is assumed to be given by

$$M_{av,n} = \frac{M_{in,n} + M_{ex,n}}{2} \quad (4)$$

The inlet and exit Mach numbers are both calculated by iteration from the relation

$$M = \frac{G}{P_T \sqrt{\frac{R T_T}{\gamma g}}} \left[\left(1 + \frac{\gamma-1}{2} M^2 \right)^{\frac{\gamma+1}{2(\gamma-1)}} \right] \quad (5)$$

Equation (5) is evaluated by the Fortran function AMACH.

The iterative loop represented by equations (3) thru (5) is contained in the subroutine DPFRLT. The sequence of calculations is to assume an exit total pressure, calculate the exit Mach number with function AMACH, evaluate the average Mach number with equation (4), and calculate the exit total pressure with equation (3). If the assumed and calculated values of exit total pressure agree within a specified fractional tolerance, the iteration is finished. Otherwise, the newly calculated exit total pressure is assumed for the next iteration loop. A nominal counter limit is installed in the iteration loop.

The fully-developed friction factor, f , is calculated from a standard correlation form

$$f = d N_{Re}^e \quad (6)$$

where the coefficient "d" and the exponent "e" are supplied by the user for

both the laminar and turbulent flow regimes. Transition is assumed to occur abruptly at $N_{Re} = 2300$ and non-fully developed flow effects (entrance length effects) can be simulated as explained on the input data forms and in the User's Instructions. The friction factor correlations are always assumed to be based on bulk temperature properties. The mean Reynolds number for the stage is used in equation (6).

Stage exit dynamic pressures are computed from the equation

$$P_{dyn} = \frac{R}{2g} \frac{G^2 T}{P_T} \left[\left(1 + \frac{\gamma-1}{2} M^2 \right)^{\frac{1}{\gamma-1}} \right] \quad (7)$$

which is incorporated into the Fortran function DYPRS.

When an interstage total pressure loss is to be calculated as a fraction of the local dynamic pressure, the appropriate coefficient is multiplied times the dynamic pressure computed function DYPRS. When the appropriate loss coefficient is to be computed by the program if an area change occurs from one stage to the next, the Fortran function LOSS is used to carry out the computation.

Both entrance and exit losses are computed by the method just described, utilizing the appropriate coefficients.

When stage exit static pressures are to be computed, the equation

$$P_{static} = P_T \left[\left(1 + \frac{\gamma-1}{2} M^2 \right)^{\frac{\gamma}{\gamma-1}} \right] \quad (8)$$

is used. It is incorporated into the Fortran function PSTAT.

III.2 Numerical Root-Finding Technique

The technique to be described has an overwhelming advantage for the present applications in that no analytical relationship need be known between the independent and dependent variables. It is, essentially, a numerical version of the conventional graphical method of extrapolation/interpolation for roots of functions.

In GFP, the inlet total pressure (PTIN) and the mass flow (W) are used as independent variables, depending on which input option is being exercised. Dependent variables can be maximum surface temperature (TWMAX), exit static pressure (PSEX), or exit total pressure (PTEX). A special application of the technique is made in calculating surface temperature, as has been noted.

Before the root-finding technique can be applied, two values of the independent variable and the corresponding values of the dependent variable must be available. The generation of "starting values" is described in the section with that name.

The second value of mass flow when the dependent value is the maximum surface temperature is calculated from

$$W_{est,2} = W_{est,1} \left(\frac{T_{wmax-calc,1}}{T_{wmax}^*} \right)^{1.25} \quad (9)$$

where the asterisk denotes the desired value. When the exit static or total pressure is the dependent variable, the second value of mass flow is calculated from

$$W_{est,2} = W_{est,1} \left[\frac{(P_{tIN} - P_{ex}^*)}{(P_{tIN} - P_{ex-calc,1})} \right]^{1.25} \quad (10)$$

The second value of inlet total temperature (with which exit static or total pressure is always the dependent variable) is calculated from

$$P_{tIN-est,2} = P_{tIN-est,1} \left(\frac{P_{ex}^*}{P_{ex-calc,1}} \right) \quad (11)$$

When the two values each of the independent and dependent variable have been obtained, the next estimate of the independent variable is obtained by linear extrapolation from

$$x_3 = \left(\frac{x_2 - x_1}{y_2 - y_1} \right) (y^* - y_2) + x_2 \quad (12)$$

where x and y are independent and dependent variables respectively, the asterisk denotes the desired value as before, and the subscripts refer to the sequential order of the estimates and the corresponding yields of the dependent variable.

Once three sets of values have been obtained and thereafter during the root-finding procedure, the next estimate of the dependent variable is always calculated by a quadratic extrapolation/interpolation which fits a parabola through the last three points calculated and uses the intersection of that parabola with the line $y = y^*$ as the next estimate of the independent variable. The parabola has its axis parallel to the "x-axis" in order to obtain single-valued results. The $i+1$ estimate of the root (value of the independent variable) is calculated from

$$x_{i+1} = \bar{a} + \frac{(y^* - \bar{b})^2}{4f} \quad (13)$$

The fitted parabola is calculated from the relations

$$\bar{b} = \frac{(y_i^2 - y_{i-2}^2)(x_{i-1} - x_{i-2}) - (y_{i-1}^2 - y_{i-2}^2)(x_i - x_{i-2})}{2[(y_{i-2} - y_{i-1})(x_i - x_{i-2}) - (y_{i-2} - y_i)(x_{i-1} - x_{i-2})]} \quad (14a)$$

$$4\bar{f} = \frac{(y_i^2 - y_{i-2}^2) + 2\bar{b}(y_{i-2} - y_i)}{x_i - x_{i-2}} \quad (14b)$$

$$\bar{a} = x_i - \frac{(y_i - \bar{b})^2}{4\bar{f}} \quad (14c)$$

Equations (12 thru (14) are coded in the subroutine EXTRAP. Convergence on the desired root is recognized for exit pressures when the fractional tolerances ACCPRS is satisfied and for surface temperatures when the absolute tolerance ACCTMP is satisfied.

III.3 Starting Values

No provision has been made for the user to load a starting value for the inlet pressure, when it is the independent variable. A starting value may or may not be loaded for mass flow. For the first case of a given computer run, the compressible flow function is used in one of the following forms when a starting value is needed:

For mass flow,

$$W = AM \sqrt{\frac{\gamma g}{R}} \frac{P_T}{\sqrt{T_T}} \left(1 + \frac{\gamma-1}{2} M^2\right)^{-\frac{\gamma+1}{2(\gamma-1)}} \quad (15)$$

in which a Mach Number of 0.1 is assumed. Equation (15) is contained in the Fortran function FLWFUN.

For inlet pressure,

$$P_T = \sqrt{\frac{R}{\gamma g}} \frac{W \sqrt{T_T}}{AM} \left(1 + \frac{\gamma-1}{2} M^2\right)^{\frac{\gamma+1}{2(\gamma-1)}} \quad (16)$$

in which a Mach Number of 0.1 is also assumed. Equation (16) is contained in the Fortran function PRSFUN.

Subsequent cases will ordinarily use a starting value carried over from a preceding case, unless a new value has been loaded for mass flow in the appropriate circumstances.

III.4 Remedial Action in the Event of Choking (subroutine UNCHKE)

If choking is encountered in one of the input options wherein the user has specified both inlet total pressure and mass flow, no remedial action

is possible; the user has chosen a flow which chokes at the specified pressure level. (Choking is assumed whenever a Mach Number of 0.9 or higher is encountered during calculations.)

For all other input options, a choking remedial action is carried out which adjusts the independent variable in a suitable fashion to remove the choke. The fact that the user has actually specified a set of conditions which lie beyond the choking limit is recognized only by exceeding a suitable counter limit on the number of times a choking remedial can be carried out.

As a preliminary to the root-finding for any of the so-called "iterative options", two bounds, WHI and WLO, are set up which no estimate of the independent variable is permitted to exceed. WHI and WLO can, of course, represent either mass flows or inlet total pressure levels. WHI is either the lowest choking value of mass flow or the lowest non-choking inlet total pressure. WLO is the highest non-choking mass flow or the highest choking inlet total pressure. For mass flow, WHI is initialized by evaluating equation (15) with a Mach Number of 0.9 and WLO is set equal to zero. For inlet total pressure, WLO is initialized by evaluating equation (16) with a Mach Number of 0.9 and WHI is set equal to 10^{30} .

When a choke is encountered, new values of the independent variable are generated by suitable application of the appropriate compressible flow function (equation (15) or (16)) combined with a check to see that such new values lie between WHI and WLO. If these bounds are exceeded, dichotomization is resorted to, wherein the new value of the independent variable is chosen as the mean of WHI and WLO which are themselves constantly updated during the choking remedial.

The detailed procedure is shown in Figure 3 which gives the logical flow chart for the subroutine UNCHKE.

III.5 Calculation of Surface Temperature

The Nusselt Numbers needed for the calculation of surface temperature are determined from standard correlations of the form

$$N_{Nu} = a N_{Pr}^b N_{Re}^c = \frac{h D_A}{k} \quad (17)$$

which is intended to yield fully developed values. Mean Reynolds Numbers for the stage are used in equation (17). Values for a, b, and c must be given for both the laminar and turbulent regimes. The question of whether the Reynolds number, N_{Re} , used in equation (17) is to be evaluated for film or bulk conditions is entirely dependent on whether the Nusselt number correlation is based on film or bulk properties. In the former case, the Prandtl Number and the thermal conductivity would also be evaluated at film temperature, T_f , which is defined by

$$T_f = (T_w + T_a)/2 \quad (18)$$

The film Reynolds Number can be computed from the bulk value by

$$N_{Ref} = N_{Reb} \frac{\mu_b}{\mu_f} \frac{T_b}{T_f} \quad (19)$$

(derivation based simply on using viscosity and density evaluated at film temperature).

A transitional flow regime is assumed to exist between true laminar and turbulent flow, the actual Reynolds Number limits being specified by the program user (values of 2000 and 8000 are otherwise assumed by the program for TRANHL (N_{Re0}) and TRANHU (N_{Re1}), respectively). The Nusselt Number in this region is computed by a curve fit which matches the laminar and turbulent Nusselt Numbers computed at N_{Re0} and N_{Re1} , respectively, and fairs smoothly into the turbulent region (that is, continuous first derivative).

The transition Nusselt Number is computed from the relationship

$$\eta = \frac{N_{Nu}}{N_{Re}^{0.4} N_{Re}^{2/3}} \quad (20)$$

where the η factor is obtained from the fitted equation

$$\ln \eta = \frac{A}{N_{Re}} + B N_{Re} + C \quad (21)$$

The curve fit coefficients can be written as

$$A = \frac{N_{Re1} N_{Re0}}{N_{Re0} - N_{Re1}} \left[\frac{N_{Re1}}{N_{Re1} - N_{Re0}} (\ln \eta_1 - \ln \eta_0) (c_T - 1) \right] \quad (22a)$$

$$B = \frac{1}{N_{Re1}} \left[\frac{A}{N_{Re1}} + c_T - 1 \right] \quad (22b)$$

$$C = \ln \eta_0 - \frac{A}{N_{Re0}} - B N_{Re0} \quad (22c)$$

The terms η_0 and η_1 are calculated by evaluating equation (20) at N_{Re0} and N_{Re1} , respectively.. The c_T is the Reynolds Number exponent for turbulent Nusselt Number. The derivation of A, B, and C is described in Appendix C.

The surface temperature can be computed from the basic heat balance as

$$T_w = T_b + \frac{G_n \Delta H_{zn} \phi_{xn} D_h}{4 \Delta L_n L} \quad (23)$$

Obviously, if the appropriate Nusselt Number correlation is based on bulk properties, the surface temperature has been calculated with one application of equation (20). However, if the correlation is based on film temperature which is itself a function of surface temperature, then recourse must be had to some sort of iterative procedure.

During the development of the GFP program, the calculation of surface temperature was attempted by iteration with non-accelerated convergence and with the method-of-secants acceleration technique (reference 7). This was done by correcting the film temperature with new values of surface temperature calculated from equation (23) until the assumed and calculated temperature agreed within the tolerance ACCTMP.

It was found that the iterations were non-convergent in some of the test cases. Therefore, the numerical root-finding technique previously described was adopted with complete success.

For application to the determination of surface temperature, the surface temperature was chosen as the independent variable and the enthalpy change of the fluid in passing thru the stage was chosen as the dependent variable. Convergence was recognized, as before, when successive estimates of surface temperature differed by less than ACCTMP.

The first two estimates of surface temperature were obtained by iteration with equation (23). It should be noted that the heat transfer coefficient used in calculating the enthalpy release must correspond to the surface temperature. This is a somewhat subtle matter during the starting iterations since the sequence of calculation during the actual root-finding is different. The i-th estimate of enthalpy release is calculated from

$$\Delta H_{calc,i} = \frac{4 h_{n,i} \Delta L_n (T_{w,i} - T_{b,n})}{G_n D_{h,n} \phi_{x,n}} \quad (24)$$

The design enthalpy release, ΔH^* , is determined for the stage from the power profile and the total enthalpy increase along the passage.

It is evident from inspection of equation (18) that, if the bulk and film temperatures differ appreciably, the film Reynolds Number will differ considerably from the bulk Reynolds Number. Since transitional flow is recognized by inspection of the bulk Reynolds Number and the curve fit described in equations (20) thru (22) is nominally based on bulk Reynolds Numbers, it is also evident that some difficulties might arise when computing transitional Nusselt Number based on film temperature. The arbitrary, but reasonable, choice was made to modify the transition boundary Reynolds Numbers by the "film factor", $\frac{Nu_b}{Nu_f} \frac{T_b}{T_f}$, as used in equation (19) when the corresponding correlation is based on film temperature.

There are some minor discrepancies remaining in both the binary deck and the listed decimal source deck for the TWLT subroutine (Figure 4) in which the preceding equations are incorporated. When only one of the Nusselt Number correlations is based on film temperature and the flow is transitional, all of the transition calculations are based on film temperature, including the modification of both transition-bounding Reynolds Numbers. The effect should be small, but if the program user is concerned, it would be necessary during transitional calculations to check which regime had the correlation based on bulk temperature and then to leave that bounding Reynolds Number unmodified by the "film effect" coefficient and to evaluate the Prandtl Number and Nusselt Number at that boundary at the proper bulk temperature.

Another error or inconsistency which the program user may wish to consider is the fact that the stage-average Reynolds Numbers are used as the bulk Reynolds Numbers, rather than the stage-exit values which would be consistent with the other practices in the analysis. Again, this error would be relatively small, particularly for short stage lengths, but for longer stages it might need to be considered.

III.6 Control of GFP "Iteration" Input Options

There are fifteen distinct input options, thirteen of which are numbered. They are numbered in the order of decreasing priority. When redundant data are loaded (more than needed for any single option) the highest priority option will actually be carried out.

The table below lists the input and calculated variables for the thirteen numbered options.

Option No.	Input Variables				Calculated Variables			
1	PTIN	TTIN	TWMAX	QTOT	PSEX	PTEX	W	TTEX
2	"	"	"	TTEX	"	"	"	QTOT
3	"	"	PSEX	QTOT	TWMAX	"	"	TTEX
4	"	"	"	TTEX	"	"	"	QTOT
5	"	"	PTEX	QTOT	PSEX	TWMAX	"	TTEX
6	"	"	"	TTEX	"	"	"	QTOT
7	PSEX	"	W	QTOT	PTIN	PTEX	TWMAX	TTEX
8	"	"	"	TTEX	"	"	"	QTOT
9	PTEX	"	"	QTOT	PSEX	PTIN	"	TTEX
10	"	"	"	TTEX	"	"	"	QTOT
11	PTIN	"	"	QTOT	"	PTEX	"	TTEX
12	"	"	"	TTEX	"	"	"	QTOT
13	"	"	TTEX	QTOT	"	"	"	W

The two remaining options are simply an isothermal pressure drop calculation or a heat transfer calculation without any pressure drop analysis.

Options 1 thru 10 are the so-called "iteration options". In 1 thru 6, the mass flow is the independent variable while the max-average surface temperature, exit static pressure and exit total pressure are, successively, the dependent variables. The inlet total pressure is the independent variable for options 7 thru 10 and, first, exit static pressure, then exit total pressure is the dependent variable. Note also that all odd-numbered iteration options have the heat release specified and hence the exit temperature must be calculated before the compressible loss analysis can be applied.

The first step in controlling the generalized set of iterations involved in the GFP program was to "group" nominally non-subscripted (single-entry) variables into tables for convenience in manipulation. This is done for the major flow and temperature variables shown in Table 1 under the mnemonic "BSI". The individual items included in the BSI-table are shown below:

BSI(i)		Individual Entry Mnemonic
1	1	PTIN
	2	TTIN
	3	TTEX
	4	TWMAX
	5	PSEX
	6	PTEX
	7	W
	8	QT OT
	9	PSX O PI (PSEX/PTIN)
	10	PTX O PI (PTEX/PTIN)
	11	TEX O TI (TTEX/TTIN)

It is pertinent to note at this point that a distinction is made in the GFP program between "input" data and "calculation" data. Specifically, "input" data refer to those data which are actually loaded into the program by the user. Such data are, virtually without exception, left intact and unmodified by the program. On the other hand, "calculation" data may refer to input data which have been transferred into other locations than those in which they were originally loaded or to output data from the calculations. The advantage of this scheme is that the user need not reload data for subsequent cases if the particular values are not being changed, since the data have not been "used-up". Furthermore, the original data are also available for later logical control purposes.

The most important example of this practice for the present purposes is the BS~~O~~ table. This table has entry points similar to those in the BSI table. It is initially filled from the contents of the BSI table and then the remainder of the table is filled by the result of the option calculations.

The option number, which has the mnemonic K~~O~~PT, is chosen by systematic inspection of the BSI table to determine what non-zero values are present. This is accomplished by the double-subscripted variable K~~O~~PSET which is dimensioned 3 x 13. This table is filled with fixed point constants (integers) which are used as subscripts in an inspection of the BSI table.

KOPSET(i,j)

i =		1	2	3
j =	1	1	4	8
	2	1	4	3
	3	1	5	8
	4	1	5	3
	5	1	6	8
	6	1	6	3
	7	7	5	8
	8	7	5	3
	9	7	6	8
	10	7	6	3
	11	7	1	8
	12	7	1	3
	13	1	8	3

All options require TTIN, hence it is inspected for separately. As soon as all three subscript entries are found to be non-zero for some j, KOPT is set equal to that j. (The KOPSET table and determination of KOPT are found in the CONSID subroutine.)

The KONOPT table, dimensioned 2 x 10, is used to retrieve the dependent and independent variables from the BSØ table. (This table is set up in the INITIAL subroutine, but functions in the ITRCON subroutine.) Its contents are as follows:

KONOPT(i,j)

j =		1	2	3	4	5	6	7	8	9	10	(KOPT)
i =	1	4	4	5	5	6	6	5	5	6	6	(dependent variable)
	2	7	7	7	7	7	7	1	1	1	1	(independent variable)

The method by which the calculation options are carried out utilizing the numerical root-finding technique previously described is shown in detail in Figure 2 which gives the logical flow diagram for the ITRCON subroutine.

III.7 Calculation of Hydraulic Diameter and Free Flow Area

There are five cross section options available in the GFP program. The first of these is general, in that the user loads both the hydraulic diameter and the free flow area for each stage. The four remaining options refer to definite cross-sectional shapes wherein the program will actually take the geometrical data and calculate the hydraulic diameter and free flow area. In the description of each option, the mnemonic is given whose value must be greater than zero for the program to recognize that the particular cross section is being used. These mnemonics are listed in the order of priority; the first non-zero one encountered is the only one the program will recognize.

- 1) Circular (ROUND).

$$A_{ff} = \frac{\pi}{4} D_h^2 \quad (25)$$

- 2) Rectangular (RECTNG).

$$A_{ff} = L_w L_h \quad (26a)$$

$$D_h = \frac{2 A_{ff}}{L_w + L_h} \quad (26b)$$

- 3) Elliptical (ELLIPS).

$$A_{ff} = \frac{\pi}{4} D_{maj} D_{min} \quad (27a)$$

$$D_h \approx \frac{4\sqrt{2}}{\pi} \frac{A_{ff}}{\sqrt{D_{maj}^2 + D_{min}^2}} \quad (27b)$$

- 4) Concentric annuli (RINGS). The number of rings here is actually the number of full-thickness rings plus two half-thickness rings. The two half-rings lie adjacent to the I.D. and O.D. and within the region between these diameters.

$$D_h = \frac{D_{outer} - D_{inner}}{n-1} - 2 t_{ring} \quad (28a)$$

$$A_{ff} = \frac{n\pi}{8} D_h (D_{outer} + D_{inner}) \quad (28b)$$

See Item 3 in the User Instruction for a description of distribution of stagewise geometry values.

III.8 Pressure Losses Resulting From Sudden Expansions and Contractions

The mnemonic AUTOLS signals the program that expansion or contraction losses are to be calculated whenever a flow area change is encountered. These calculations are carried out in the subroutine LOSS using the incompressible loss equations described below. The equations were taken from an internal General Electric report, but the results are similar to those described in reference 5.

In the equations below, the subscript 1 refers to upstream conditions while 2 refers to downstream. The dynamic pressure is denoted by q and the loss coefficient by C_L .

- 1) Contraction loss.

$$\frac{F}{F} = 1 - \left[\left(\frac{2 + A_2/A_1}{5.1415927} \right) \sqrt{1 - \frac{A_2}{A_1}} \right] \quad (29)$$

$$C_L = \left[(1/\xi - 1) / (A_2/A_1) \right]^2 \text{ based on } g_1 \quad (30a)$$

or

$$C_L = (1/\xi - 1)^2 \text{ based on } g_2 \quad (30b)$$

Equation (30a) is the one actually used by the GFP program for contraction losses, since the downstream compressible dynamic pressure required by equation (30b) would require an extra iteration

2) Expansion loss.

continued on next page

$$C_L = \left[1 - \left(\frac{A_1}{A_2} \right) \right]^2 \text{ based on } g_1 \quad (31a)$$

or

$$C_L = \left[\left(\frac{A_2}{A_1} \right)^2 - 1 \right]^2 \text{ based on } g_2 \quad (31b)$$

Equation (31a) is employed by GFP for the same reason mentioned above.

III.9 Logical Control For Parametric Studies

Parametric cases are those in which one or more of the flow and temperature variables are systematically varied over an incremental range of values. There is no limit on how many parametric "points" can be generated by a single record of input data. All successful parametric calculations are automatically printed out in the summary tables.

As would be deduced from the previous discussion of the logic used to control the iterations, parametric control is also accomplished by proper grouping of variables and by a table filled with suitable subscripts.

All eight of the so-called flow and temperature variables can be incremented in this fashion, although obviously only those occurring as input data for the current input option will be active. The increment mnemonics themselves are designated by prefixing the letter "D" to the regular input mnemonics. The mnemonics generated by prefixing either "NØ" or "N" to the regular input mnemonics are used to signal the number of times the original value of the variable is to be incremented plus one.

Increment mnemonics are grouped in the tables DPARAM (input) and DPARMR (calculation). Increment counters are grouped in the tables KPARAM (input) and KPARMR (calculation). All of these tables are ordered to correspond to the BSØ table so that a single subscript supplies access to corresponding quantities in all of the tables.

The actual stepping of the running counters, resetting counters, and incrementing and restoring the variables themselves are accomplished with the KØNPAR table which is dimensioned 4 x 13 (4 variables for each option) and filled with fixed point constants. Its contents are

KØNPAR(i,j)

	j = 1	2	3	4	5	6	7	8	9	10	11	12	13
i = 1	8	3	8	3	8	3	8	3	8	3	8	3	8
2	4	4	5	5	6	6	7	7	7	7	7	7	3
3	2	2	2	2	2	2	5	5	2	2	2	2	2
4	1	1	1	1	1	1	2	2	6	6	1	1	1

The detailed program logic for parametric studies is shown in the logical flow chart in Figure 5.

III.10 Entrance Length Effects

The relationships used to calculate the entrance length effects (that is, non-fully developed flow) on heat transfer and wall friction were developed by R. T. Lancet and, as was the case for the transitional heat transfer relationships previously described, they were originally presented in an internal General Electric Company report. The relationships will be presented below without discussion, although the sources of data originally considered by Lancet are referenced.

The Nusselt Numbers calculated with equation (17) are fully-developed values and are designated by the ∞ -subscript. Similarly, fully developed friction factors are computed from user-supplied correlations of the form

$$f_{\infty} = d N_{Re}^e \quad (32)$$

for both the laminar and turbulent regimes. Transition for frictional purposes is assumed to occur sharply at a Reynolds Number which can be designated by the user (the program will assume 2300 if no value is loaded as input data).

Entrance length effects on laminar heat transfer ($N_{Re} \leq N_{Re0}$) are computed from the equation (reference 3)

$$N_{Nu} = \left[N_{Nu\infty}^3 + 1.56 \frac{\pi}{4} N_{Re} N_{Pr} (D_h/X) \right]^{1/3} \quad (33)$$

Entrance length effects on turbulent ($N_{Re} \geq N_{Re1}$) heat transfer are computed from the equation (reference 1)

$$N_{Nu} = 1.5 N_{Nu\infty} (D_h/X)^{.16} \text{ if } \frac{X}{D_h} \leq N_{Re}^{1/4} \quad (34a)$$

or from

$$N_{Nu} = N_{Nu\infty} \text{ if } \frac{X}{D_h} > N_{Re}^{1/4} \quad (34b)$$

Entrance length effects on laminar friction factor ($N_{Re} \leq N_{ReT}$) are computed from

$$f = f_{\infty} [1 + \beta_1 N_{Re} (D_h/X)] \quad (35)$$

For turbulent friction factor ($N_{Re} > N_{ReT}$), the entrance length effects are computed from

$$f = f_{\infty} [1 + \beta_2 (D_h/X)] \quad (36)$$

Both equation (35) and (36) are based on data and discussions in reference 4. Lancet recommended values of 0.005 for β_1 and 10.0 for β_2 .

IV

LOGICAL ORGANIZATION OF THE GFP PROGRAM

The sequence of operations in the GFP program, apart from initialization, is as follows:

1. Load input data (SR READIN)
2. Process input data (SR DATPRØ)
3. Check input data for consistency and adequacy (SR CØNSIS)
4. Print out input data (SR INPPRT)
5. Carry out calculations if no input errors found (SR ITRCØN)
6. Print out results of calculations (SR ØUTPUT and/or SUMPRT)
7. Reset data fields for next calculation. .Return to 1).

Virtually all data are in CØMMØN storage and are "fixed" in CØMMØN by means of EQUIVALENCE statements. This is very convenient when it is desired to rearrange the storage map. Since large blocks of mnemonics can be relocated en masse without revising long lists attached to CØMMØN statements. In addition, it provides complete freedom of action in the use of further EQUIVALENCE statements.

V USER INSTRUCTIONS

V.1 Instructions

Introduction

The General Flow Passage computer program (ANP 663, for the IBM 7090) calculates the subsonic compressible pressure losses and associated temperature levels for a single flow passage of arbitrary geometry filled with any one of a variety of flowing gases. The program contains many features which enable it to satisfy most reasonable design restraints without the necessity for cross-plotting of results and which enable the user to avoid the need for redundant entry of data.

General Flow Passage is intended as a complete replacement for the Modified Off-Design program (ANP 443) which exists only for the IBM 704 and is a much more primitive program.

Definitions

Flow passage - Any series or connected group of flow elements, either components and/or enclosed flow channels, all characterized by carrying the same mass flow.

Stage - Any individual element of a flow passage. Usually, a stage refers to an incremental length along an enclosed flow channel, but zero length stages can be used to simulate arbitrary flow elements, such as valves and orifices, but means of user-specified total pressure loss coefficients.

Case - A complete pressure loss and heat transfer calculation for all stages of a flow passage.

Record of input data - All data included between cards bearing end-of-record punches. Except for some special option control variables, should normally include all original or changed data needed by the program to carry out the desired type of calculation.

End-of-record punch - A column 1 punch which is either an = (equal - sign; 8-3 punch) or an → (arrow or dash; 8-4 punch).

Summary of Features

The brief descriptions below are intended only to indicate the capability of the General Flow Passage program. Further explanations will be given later for those features which are not self-evident from the input forms.

Input/Output Units Normally inches (direct and derived quantities) and degrees F. Optionally, feet and/or degrees R can be separately used in input and/or output.

Geometry-Length The passage can be subdivided into as many as 100 increments (ie, "stages") of arbitrary length. Zero lengths are permissible to permit simulation of valves, orifices, etc. Stage lengths can be inputted by individual lengths or by fractional stations of a total length.

Geometry-Cross Section Five options exist:

1. General; user supplies hydraulic diameter and free flow area.
2. Round; user supplies diameter.
3. Rectangular; user supplies height and width.
4. Elliptical; user supplies major and minor axes.
5. Concentric rings; user supplies inner diameter, outer diameter, thickness of rings, and number of rings. (Inner and outer rings are assumed to be of half-thickness.)

Flow and Temperature Input There are fifteen options available which are automatically selected by the program on the basis of the input data. These will be discussed in detail in a later section.

Partial Printout It is possible to have only flow and temperature input and output printed out for each case or to completely suppress the input printout.

Summary Printout The program builds up a table of flow and temperature output and will print out the table upon command or when the program has carried out calculations for 100 cases.

Interstage Losses The user may specify interstage loss coefficients or have the program calculate incompressible loss coefficients (with or without modifying multipliers) when flow area changes occur.

Distribution of Repetitive Stagewise Input A method is provided for sequential distribution of a repetitive variable so that the user does not have to have long strings of identical numbers on the input forms.

Laminar, Turbulent, and Transitional Flow An abrupt transition is assumed for pressure drop (ie, friction factor) at a Reynolds Number which can be designated by the user. For heat transfer, transition is assumed to occur over a Reynolds Number range which can also be designated by the user. Heat transfer coefficient correlations can be based on bulk or film temperatures of the flowing gas.

Entrance Length Effects The program user can have non-fully-developed flow simulated by prescribed relationships which will be described in the analysis.

Parametric Studies An indefinitely large number of cases can be generated from a single record of input data to facilitate parametric studies which require systematic variation of flow and temperature input parameters.

Built-In Data Checking The program has a rather elaborate set of checks to insure that both sufficient and self-consistent input data have been provided. If the program finds that inadequate input data were provided, it will ordinarily not carry out any more calculations (to conserve computer time) and will merely check the remaining input data to insure that there are no DIP-type data which would cause subsequent data loading errors.

An option exists (variable ALLRUN, form 7) which will cause the program to carry out calculations whenever it finds adequate data have been loaded. The user must recognize that, if data are collected piecemeal in this fashion from various input records, the case for which calculations are finally carried out may bear no resemblance to anything the user had in mind. (If the program once finds a DIP-type input error, for instance, none of the remaining data in that record will be loaded into the program.)

Some Detailed Instructions

1. Flow and Temperature Input

As was noted in the introductory remarks, there are 15 distinct input options available in terms of which variables are inputted and which are calculated by the program. In order to describe these options systematically, the following list of input/output variables will be used:

PTIN Inlet total pressure
 TTIN Inlet total temperature
 W Passage mass flow
 TWMAX Maximum stage-exit surface temperature.
 TTEX Bulk exit total temperature.
 PTEX Exit total pressure
 PSEX Passage exit face static pressure
 QTOT Heat addition to gas in passage (may be negative)

The thirteen major input options are tabulated below.

Option No.	Input Variables				Calculated Variables			
1	PTIN	TTIN	TWMAX	QTOT	PSEX	PTEX	W	TTEX
2	"	"	"	TTEX	"	"	"	QTOT
3	"	"	PSEX	QTOT	TWMAX	"	"	TTEX
4	"	"	"	TTEX	"	"	"	QTOT
5	"	"	PTEX	QTOT	PSEX	TWMAX	"	TTEX
6	"	"	"	TTEX	"	"	"	QTOT
7	PSEX	"	W	QTOT	PTIN	PTEX	TWMAX	TTEX
8	"	"	"	TTEX	"	"	"	QTOT
9	PTEX	"	"	QTOT	PSEX	PTIN	"	TTEX
10	"	"	"	TTEX	"	"	"	QTOT
11	PTIN	"	"	QTOT	"	PTEX	"	TTEX
12	"	"	"	TTEX	"	"	"	QTOT
13	"	"	TTEX	QTOT	"	"	"	W

The option numbers above describe the descending order of priority. In the event that the user has supplied more data than are needed for any single option, the program will select the highest priority option for which sufficient data are present.

Two more relatively trivial options are provided:

- #14 - Supply PTIN, TTIN, and W and also a value of TTEX identical to that supplied for TTIN. The program will carry out an isothermal pressure drop calculation.
- #15 - Supply PTIN, TTIN, W, and TTEX and also a value of PTEX equal to the value supplied for PTIN. The program will carry out a heat transfer calculation without any pressure drop calculation.

2. Parametric Study Calculations from a Single Record of Input Data

It is possible to generate an indefinitely large number of cases from a single record of input data when it is desired to systematically vary the flow and/or temperature parameters for a passage of fixed geometry.

Two additional pieces of data must be provided for each parameter to be varied; 1) the number of times plus one that the starting value is to be incremented, and 2) the magnitude and sign of the increment. The variable names to be used are shown on input form 6. If the user neglects to load a non-zero increment for a variable, the program will conserve time by not uselessly incrementing the variable in question.

The order of variable incrementing is that implied in the variable listing previously given for option 1, proceeding from right to left. For example, the order of incrementing for option 7 would be W, PSEX, QTOT, and then TTIN.

3. Distribution of Repetitive Stagewise Input

It frequently occurs that a given piece of stagewise data, such as stage length, will be repeated for many successive stages. To avoid the monotony (and added chance for error) which would arise from the necessity of writing and having keypunched such a series of identical numbers, virtually all tabular input can be distributed over successive stages by means of what are called "distribution variables". These are labeled on the input forms and include NLEN, NDH, NAFF, etc.

Useage of the distribution variables is accomplished by writing pairs of numbers after the appropriate variable. The GFP program (using the subroutine DSTRE1) will take whatever value is found in the stage designated by the first number of each pair and distribute that value into all successive stages up to and including the one designated by the second number of each pair. Examples of this can be found in the input for the sample problems in Section VI.

All tabular input which can be distributed in this fashion appears on the input forms with the name followed by an equals-sign (=). The equals sign is intended to aid in "spotting" values into particular stage locations. When "n =" appears after the name of a variable (where n is an integer), it signifies that the next value is to go into the n-th stage. When "n =" appears after a value rather than after the name of a variable, it signifies that n stages are to be skipped before inserting the next value in a stage.

By way of an example, the following three sets of input data cards will all result in the same stagewise variation of hydraulic diameter:

3DH,1 = ,.2,.2,.4,.5,.5,.5,.5,.5,.5,.8,.8,.8,.8,
or

3DH,1 = ,.2,DH,3 = ,.4,.5,DH,10 = ,.8,
4NDH, 1,2, 4,9, 10, 13,

or

3DH,1 = ,.2,1 = ,.4,.5,5 = ,.8,
4NDH, 1,2, 4,9, 10,13,

V.2 Input Data Forms

Input Data Forms for the General Flow Passage
Computer Program (ANP 663)

Analyst _____ Phone _____ Date _____

Problem _____ Page _____ of _____

See "General Flow Passage Computer Program (ANP 663)" by S. C. Skirvin, GE-ANPD, Report APEX 664, 8/61 (U) for analyses, instruction, and error printout code.

Note: All variables assumed zero by program unless otherwise noted. All controls inoperative unless values greater than zero loaded.

Optional Identification

1 2

Punch on
one card

2 HEADER,10, (1)

1 2 Up to 59 characters including blanks

4 CASE, ,CASTEP, ,

Case no. (1)

Increment between case numbers (1)

Gas Selector

3 GAS, , (Assumes air)

1 for air, 4 for H₂, 6 for He, 9 for Ne (presently available)

Input/Output Unit Controls

3 FTIN, , RNKIN, , FTOUT, , RNKOUT, ,

Feet input

OR input

Feet output

OR output

Printout Controls

4 PRTALL, , NØINPT, , NØGEØM, , PARPRT, , NØPRT, ,

Print all stage-
wise output

Suppress input
data printout

Suppress geomet-
rical input
printout

Suppress all
stagewise input
data and output
printout

Suppress all
normal print-
out (but
permits summary
printout)

HEAT TRANSFER AND FRICTION CHARACTERISTICS

Heat Transfer Correlations (must have at least coefficients)

3 CØFHLM, , EXHPLM, , EXHRLM, ,

(Laminar)

3 CØFHTB, , EXHPTB, , EXHRTB, ,

(Turbulent)

Coefficient

Prandtl No. expon. Reynolds No. Expon.

Input Data Forms for the General Flow Passage
Computer Program (ANP 663)

Analyst _____ Phone _____ Date _____

Problem _____ Page _____ of _____

Correlation Reference Temperatures

1 2

4	LMBULK,	TBULK,		If > 0, use bulk instead of film temperature.
	Laminar	Turbulent		

Friction Factor Correlations (must be present)

3	C _{OFFLM} ,	EXPFLM,		(Laminar)
3	C _{OFFTB} ,	EXPFTB,		(Turbulent)
	Coefficient	Reynolds No. Expon.		

Transition Reynolds Numbers

3	TRANHL,	TRANHU,	TRANSF,	
	Upper laminar limit (2000)	Lower turbulent limit (8000)	Abrupt frictional transition (2300)	

Transition range for convection

Entrance Length Effects (optional)

4	ENTRNC,		If > 0, signals entrance length effects to be calculated.
3	BETA1,	BETA2,	Coefficients for friction effects
	Laminar	Turbulent	

Flow (need not be provided for options 1 thru 6 or for 13)

3	W,	(Value loaded for options 1 thru 6 will be used as first guess)
---	----	---

Temperatures (only TTIN must always be loaded)

3	TTIN,	TTEX,	TEX/TTIN,	TWMAX,	
	Inlet total	Exit total	TTEX/TTIN	Max-ave surface temp.	

4	MAXTMP,	If > 0, TWMAX will be attained at that stage.
---	---------	---

Heat Release (Use QTOT alone or Q/QBAR and QBAR)

3	QTOT,	Q/QBAR,	QBAR,	
	Total heat release	QTOT/QBAR	Reference heat release	

Input Data Forms for the General Flow Passage
Computer Program (ANP 663)

Analyst _____ Phone _____ Date _____

Problem _____ Page _____ of _____

Pressures (PTIN must be given except for options 6 thru 10)

1 2

3	PTIN,	,PTEX,	,PTIN,	,
---	-------	--------	--------	---

Inlet total Exit total Exit static

Exit Pressure Ratio (Cannot be used with options 6 thru 10)

3	PTXOPT,	,PSXOPT,	,
---	---------	----------	---

P_{TEX}/P_{TIN}

P_{SX}/P_{TIN}

GEOMETRY

4	STAGES,	,	(max of 100)
---	---------	---	--------------

No. of stages

Stage Lengths

Either

3	LENGTH,	=,

Physical lengths

and (optional)

4	NLEN, (1)	,	(1)

Stagewise distribution variable for LENGTH table

or

3	TOTLEN,	,	Total passage length
---	---------	---	----------------------

and

3	XOL,

Fraction of total length to end of each stage (ie, last value must be one)

Cross Section

4	ROUND,	,RECTNG,	,ELLIPS,	,RINGS,	,
---	--------	----------	----------	---------	---

Round

Rectangular

Elliptical

Concentric rings

(Maximum of one non-zero value above; general cross section if all zero.)

**Input Data Forms for the General Flow Passage
Computer Program (ANP 663)**

Analyst _____ Phone _____ Date _____

Problem _____ Page _____ of _____

1 2

3	, =,

If general or round load DH(hydraulic diam.); if rectangular load WIDTH;
if elliptical load ELPMAJ(major axis); if concentric rings load D_{OUTER}
(outer diam.)

4	NDH, (1) , (1)

Stagewise distribution variable for above table

3	, =,

If general load AFF (free flow area); if rectangular load HEIGHT; if elliptical
load ELP_{MIN} (minor axis); if concentric rings load D_{INNER} (inner diam.)

4	NAFF, (1) , (1)

Stage wise distribution variable to be used only for AFF (general cross section)

If concentric rings, must also have

3	THICK, =,

Ring thickness

4	NORING, =,

No. of rings

Entrance and Exit Loss Coefficients (optional)

5	CIN, , CEX, ,

Entrance Exit

Automatic Interstage Losses (optional)

4	AUTOLS, , If > 0, generates loss coefficient at area changes
---	--

Form 5 of 7
Input Data Forms for the General Flow Passage
Computer Program (ANP 663)

Analyst _____ Phone _____ Date _____

Problem _____ Page _____ of _____

1 2

3	CLSMOD, =,

Multipliers for automatically calculated loss coeff. (All normally equal to one)

4	NCLSMOD, (1) , , (1)

Stagewise distribution variable for CLSMOD table.

Arbitrary Interstage Losses (optional)

3	CLOSS, =,

Loss coefficients

4	NCLLOSS, (1) , , (1)

Stagewise distribution variable for CLOSS table

Power Profile (must be supplied unless running isothermal case with $T_{TEX} = T_{TIN}$)
either

3	PHISUM,

Fraction of total power released by trailing edge of each stage (ie, integrated)
and

3	PHIEX,

Ratio of trailing edge to stage average power for each stage
or (non-integrated)

3	P0,

Relative power level at stage leading edges.
and

3	P1,

Similar to P0, but for midpoints of stages

Input Data Forms for the General Flow Passage
Computer Program (ANP 663)

Analyst _____ Phone _____ Date _____

Problem _____ Page _____ of _____

and

1 2

3	P2,

Similar to P0, but stage trailing edges

Parametric Setup

No. of times to be incremented plus one

4	NØPTIN,	,NØTTIN,	,NØTWMX,	,NØQTØT,	,
4	NØPSEX,	,NØPTEx,	,NØW,	,NØTTEX,	,

The letters "NØ" have been added to base variables.

Size of increments

3	DPTIN,	,DTIN,	,DTWMAX,	,DQTØT,	,
3	DPSEX,	,DPTEX,	,DW,	,DTTEX,	,

The letter "D" has been added to the base variables.

Heat Transfer Coefficient and Friction Factor Stageswise Multipliers (all initialized equal to one)

3	HMULT,	=,

Heat transfer coefficient multipliers

4	NHMULT, (1)	,	(1)

Stageswise distribution variable for HMULT table

3	FMULT,	=,

Friction factor multipliers

4	NFMULT, (1)	,	(1)

Stageswise distribution variable for FMULT table.

Input Data Forms for the General Flow Passage
Computer Program (ANP 663)

Analyst _____ Phone _____ Date _____

Problem _____ Page _____ of _____

Accuracy Criteria (fractional unless otherwise noted)

1 2

3	ACCMNØ,	,ACCPRS,	,ACCTMP,	,	
	Mach No. (0.0001)	Pressure (0.0001)	Temperature (0.049 deg)		

Counter Limits

4	LIMTRY,	,LIMCHK,	,LMCHTØ,	,LIMPRS,	,
	Tries to satisfy option iteration (15)	Choke adj. for single value of independent vari- able (10)	Total no. of choke adj. for a case (30)	Max. tries for a stage exit pressure or exit surface temp. (20)	

Miscellaneous

3	MAXMNØ,	,	Max. Mach No. choke remedial tries to exceed (0.5)
4	ALLRUN,	,	If > 0, program will calculate anytime it finds sufficient data regardless of previous errors.
4	NEWSET,	,	Output from this case will be placed into internal input tables with QBAR = QTØT. (Resets to zero)

End of Record (must be last card of data record)

Punch this 1 2

Summary Printout (No other action taken when this piece of data is loaded; causes summary printout of all previous successful cases during run. Resets to zero.)

=	PRTSUM,1,
---	-----------

V.2 Error Code Printout

<u>TYPE,LOC</u>	<u>Nature of Error</u>
where 1 n 100 = stage number	
n,1	no DH when LENGTH 0
n,2	no AFF when LENGTH 0
n,3	no AFF when LENGTH=0
99,99	Reentry 1st statement of main program without sense light 1 on.
101,1	Missing data; no PIN
101,2	Missing data; no TIN
102,1	Missing data; no CØFFLM
2	Missing data; no EXPFLM
3	Missing data; no CØFFTB
4	Missing data; no EXPFTB
103,1	Missing data; no CØFHLM
4	Missing data; no COFHTB
104,104	Neither pressure drop nor heat transfer requested
105,105	No entrance length effect coefficients; will not stop program (BETA1)
106,106	No BETA2
108,n	XØL(n) less than XØL(n-1)
108,0	No XØL table when TOTLEN > 0
109,0	XØL ≠ 1 for last stage
150,1	Too little data; needed both QTØT and TEX
151,1	No power profile with non-isothermal calculation
152,152	More than 100 stages specified. Prevents all other consistency checking.
160,	Choke troubles leading to convergence failure
1	Not iterating when choke encountered
2	Specified conditions resulted in irremovable chokes
3	Total no. of choke relief attempts exceeded limit
4	Too many tries for a single-choke relief
170,1	Could not satisfy basic iteration in specified no. of tries
2	Unable to converge with two reductions in pressure tolerance fraction
180,N	Unable to obtain stage exit press. for stage N in LIMPRS tries.

190,N	Unable to obtain trailing edge surface temperature for stage N in LIMPRS tries.
200,1	Failed to carry out calculation when NEWSET > 0.
520,N	Pulled in stage N while iterating for wall temp.
999,1	Pulled in iteration loop for time.

VI. SAMPLE PROBLEMS

In a program with as many features as GFP, it would be prohibitive to attempt to demonstrate every feature by a sample problem. In the following examples, however, a fairly extensive sampling has been included.

A listing of the input data cards is given first, followed by reproductions of many of the pages of computer output. Missing pages were essentially duplicates of pages already shown.

```

2HEADER 10  OPTION 1
3GAS 1
3ALLRUN 1
4CASE,2,STAGES,10,CASTEP,2,
3COFHLM,4,23,
3COFHTB,.0205,EXHPTB,.4,EXHRTB,.8,
3COFFLM,16,EXPFLM,-1,
3COFFTB,.046,EXPFTB, .2,
3C1,.75,C2,.75,
3QLSUB,1=,3,DHGSUB,1=,.5,AFFSUB,1=,.19635,
4NOL,1,10,NDHG,1,10,NAFF,1,10,
4LIMPRS 40
3PRTALL,1,
3PTIN,23.45,TTIN,91,TWMAX,1235.16,QTOT,4.7715,
3TWMAX,1237.92,
3P0,1,1,1,1,1,1,1,1,1,1,
3P1,1,1,1,1,1,1,1,1,1,1,
3P2,1,1,1,1,1,1,1,1,1,1,
=
2HEADER 10  OPTION 2
3QTOT,0,TTEX,500,W,.01,
=
3PRTALL 0
2HEADER 10  OPTION 3
3QTOT,4.7715,TTEX,0,PSEX,15.951,W,.01,TWMAX,0,
=
3PARPRT 1
2HEADER 10  OPTION 4
3QTOT,0,TTEX,500,W,.01,
=
3PARPRT 0
2HEADER 10  OPTION 5
3QTOT,4.7715,TTEX,0,PTEX,16.841,W,.01,PSEX,0,
=
2HEADER 10  OPTION 6
3QTOT,0,TTEX,500,W,.01,
=
2HEADER 10  OPTION 7
3QTOT,4.7715,TTEX,0,W,.0478063,PTIN,0,PSEX,15.951,
9 PIND AT 32250
C32250,0,
=
2HEADER 10  OPTION 8
3QTOT,0,TTEX,500,
C32250,0,
=
2HEADER 10  OPTION 9
3QTOT,4.7715,TTEX,0,PSEX,0,PTEX,16.841,
C32250,0,
=
2HEADER 10  OPTION 10
3QTOT,0,TTEX,500,
C32250,0,
=
2HEADER 10  OPTION 11
3QTOT,4.7715,TTEX,0,PTIN,23.45,PTEX,0,
=
2HEADER 10  OPTION 12
3QTOT,0,TTEX,500,

```

```

=
4PRTALL 1
2HEADER 10 OPTION 13
3W 0 QTOT 4.7715
=
3W .25
2HEADER,10, RINGS
4ROUND,0,
4NDH,1,10,NORING,1=,12,
3RINGS,1,DINNER,1=,.382,DOUTER,1=,2.853,THICK,1=,.023585,
=
2HEADER 10 RECTANGULAR
3W,.01,
=RINGS 0 RECTNG 1 WIDTH 1=,.20 HEIGHT 1=,.25
=W .005
2HEADER 10 ELLIPTICAL
3W 4.78042 2
=RECTNG 0 ELLIPS 1 ELPMAJ 1=,.6 ELPMIN 1=,.4
3AFF,1=,0,
4NAFF 0
2HEADER,10, INTERSTAGE LOSSES
3CLOSS,2=,.5,CLOSS,7=,.75,
4NCLOSS,2,3, 7,9,
3ROUND,1,ELLIPS,0,DH,1=,.5,
3W .03
=
4PRTALL,1,
2HEADER,10, AUTO INTERSTAGE LOSSES
3DH,1=,.4,1=,.5,3=,.4,AUTOLS,1,
4NDH,1,2, 3,6, 7,10,
=
2HEADER,10, MODIFIED AUTO INTERSTAGE LOSSES
3CLSMOD,2=,.75,3=,.75,
=
2HEADER 10 X/L STAGE LENGTH INPUT
4NLEN 0 0
3LENGTH 1=,0 TOTLEN 30
=XOL .1 .2 .3 .4 .5 .6 .7 .8 .9 1
3PRTSUM,1,
=
8

```

THE FOLLOWING CARDS ADDED TO THE OPTION 12 INPUT RECORD ABOVE
 RESULTED IN THE PARTIALLY INCLUDED OUTPUT LABELED - PARAMETRIC

```

2HEADER,10, PARAMETRIC
3DPTIN,5,DTTIN,100,DTTEX,100,DW,-.01,
4NOPTIN,2,NOTTIN,2,NOTTEX,2,NOW,2,

```

\$ XEQ

ENTRY POINTS TO SUBROUTINES REQUESTED FROM LIBRARY,

(FPT)	(SPH)	(FIL)	LOG	EXP	EXP(3
SQRT	(DIP)	(TSHM)	(RTN)	(BST)	(IOH)
(WER)	(TES)	(WRS)	(WTC)	(RCH)	
LMPROP 00150	NOPROP 00206	000000 00253	CONSIG 00456		
CONTMP 01342	DPFRLT 01472	FRCFAC 02562	DATPRO 03025		
INITAL 04212	INPPRT 04523	ITRCON 06777	OUTPUT 10707		
PRTUNT 12514	READIN 13324	RESET 14707	SETYLD 15127		
SUMPRT 15321	TWLT 16215	UNCHKE 20027	GAM 20672		
PRN 21214	R 21534	TC 21661	TMPENT 22202		
VISC 23213	AMACH 23533	DSTRB1 23762	DYPRS 24171		
EXTRAP 24312	FLWFUN 24556	FPRNT 24722	LOSS 25014		
NETERR 25277	POWER3 25355	PRSFUN 25535	PSTAT 25671		
TPINSP 25775	XPRNT 26125	BOTTOM 27105	COLUMN 27070		
NOHEAD 27100	HDING 27061	NEWSET 27052	PAGES 27037		
LINES 27045	RESTO 27035	(STHM) 27352	(STH) 27347		
NOPAGE 27076	ANPIPM 27132	WOT 27442	(FPT) 27600		
EXP 27740	LOG 27653	EXP(3 27625	SQRT 30025		
(TSHM) 30113	(TSH) 30110	(SPH) 30136	(BST) 30431		
(WTC) 30521	(WER) 30470	(RDC) 30600	(RER) 30556		
(RTN) 32264	(FIL) 32253	(IOH) 30616	(TCO) 32535		
(TEF) 32534	(RCH) 32533	(ETT) 32532	(REW) 32531		
(WEF) 32530	(BSR) 32527	(WRS) 32526	(RDS) 32525		
(IOS) 32446	(TRC) 32536	(EXE) 32601	(IOU) 33362		
(DIP) 33406	ERRORA 34624	ERROR 34625	EXIT 35046		
(TES) 35070					

EXECUTION

Ran 2.022 minutes without parametric

OPTION 1

*** GENERAL FLOW PASSAGE (ANP 663) ***
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 2 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0.

CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA
1	0.	3.0000+00	5.0000-01	1.9635-01
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	0.	0.	0.	0.

OPTION 1

OPTION 1

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 2 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
2	0.2000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
3	0.3000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
4	0.4000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
5	0.5000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
6	0.6000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
7	0.7000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
8	0.8000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
9	0.9000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
10	1.0000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000

OPTION 1

OPTION 1

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 2 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 0.
 INTENDED ENTRANCE LENGTH EFFECT = 0.
 BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	1.0000	1.0000	1.0000
2	0.	1.0000	0.2000	1.0000	1.0000	1.0000	1.0000
3	0.	1.0000	0.3000	1.0000	1.0000	1.0000	1.0000
4	0.	1.0000	0.4000	1.0000	1.0000	1.0000	1.0000
5	0.	1.0000	0.5000	1.0000	1.0000	1.0000	1.0000
6	0.	1.0000	0.6000	1.0000	1.0000	1.0000	1.0000
7	0.	1.0000	0.7000	1.0000	1.0000	1.0000	1.0000
8	0.	1.0000	0.8000	1.0000	1.0000	1.0000	1.0000
9	0.	1.0000	0.9000	1.0000	1.0000	1.0000	1.0000
10	0.	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

OPTION 1

OPTION 1

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 2 FLOW INPUT DATA (GAS IS AIR ,NO 1.)
 * * * WILL EXECUTE OPTION NO 1 * * *

FRICTION FACT AND HEAT TRANSFER CORRELATION FORMS

$N(NUS) = A * (N(PR) ** B) * (N(RE) ** C)$

$F = D * (N(RE) ** E)$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

AL= 4.230+00, BL= 0., CL= 0.

AT= 2.050-02, BT= 4.000-01, CT= 8.000-01

DL= 1.600+01, EL= -1.000+00, DT= 4.600-02, ET= -2.000-01

BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)

LAMINAR = 0 TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.0000+03 TO 8.0000+03

TRANSITION FOR FRICTION AT 2.3000+03

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP
INLET	2.34500+01		91.00
EXIT	0.	0.	0.
EX/IN	0.		0.
PSEX/PTIN = 0.			
WEIGHT FLOW = 0.			
HEAT RELEASE = 4.77150+00			
QBAR = 0. Q/QBAR = 0.			
MAX WALL TEMP = 1237.92 AT STAGE NO 0			

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS MACH NO WALL TEMP(DEG)
 10.000-05 10.000-05 0.05

COUNTER LIMITS ON ITERATIONS

OPTION ITERATION = 15

CHOKES/WT FLOW = 10 CHOKES/CASE = 30

STAGE PRESS AND WALL TEMP = 40

OPTION 1

OPTION 1

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 2 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 4.78042-02 MAX AVE WALL TEMP = 1237.92 AT STAGE 10
HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.1999+00	0.2777	9.59121+03
EXIT	16.840	15.950	500.0	2.8201+00	0.5056	7.87759+04
IN-EX	6.6098+00		-409.02			
RATIO	0.71813		1.7423	PSEX/PTIN = 0.68018		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	8.9993-01	22.550(AFTER)
EXIT	7.5000-01	2.1151+00	18.955(BEFORE)

CASE 2 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.30	0.	132.5	1084.4	0.3059	1.12093+05
2	22.03	0.	173.8	1087.6	0.3223	1.06621+05
3	21.74	0.	215.1	1096.1	0.3395	1.01762+05
4	21.43	0.	256.2	1108.9	0.3575	9.74210+04
5	21.09	0.	297.2	1125.0	0.3768	9.35202+04
6	20.73	0.	338.1	1143.8	0.3974	8.99971+04
7	20.34	0.	378.8	1164.9	0.4200	8.68003+04
8	19.92	0.	419.4	1187.8	0.4449	8.38872+04
9	19.46	0.	459.8	1212.2	0.4731	8.12224+04
10	18.96	0.	500.0	1237.9	0.5056	7.87759+04

OPTION 1

OPTION 1

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 2 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	1.3679+00	20.90	0.	1.0637-04	4.4962-03	2.4346-01
2	1.4888+00	20.50	0.	1.1081-04	4.5414-03	2.4346-01
3	1.6158+00	20.08	0.	1.1493-04	4.5840-03	2.4346-01
4	1.7499+00	19.62	0.	1.1875-04	4.6241-03	2.4346-01
5	1.8924+00	19.13	0.	1.2232-04	4.6620-03	2.4346-01
6	2.0450+00	18.61	0.	1.2566-04	4.6980-03	2.4346-01
7	2.2102+00	18.03	0.	1.2880-04	4.7321-03	2.4346-01
8	2.3909+00	17.41	0.	1.3177-04	4.7645-03	2.4346-01
9	2.5920+00	16.72	0.	1.3457-04	4.7954-03	2.4346-01
10	2.8201+00	15.95	0.	1.3722-04	4.8248-03	2.4346-01

OPTION 2

OPTION 2

*** GENERAL FLOW PASSAGE (ANP 663) ***
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 4 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0. CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA
1	0.	3.0000+00	5.0000-01	1.9635-01
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	0.	0.	0.	0.

OPTION 2

OPTION 2

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 4 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
2	0.2000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
3	0.3000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
4	0.4000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
5	0.5000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
6	0.6000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
7	0.7000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
8	0.8000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
9	0.9000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
10	1.0000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000

OPTION 2

OPTION 2

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 4 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 0.
 INTENDED ENTRANCE LENGTH EFFECT = 0.
 BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.	1.0000	0.2000	1.0000	0.	0.	0.
3	0.	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	1.0000	0.6000	1.0000	0.	0.	0.
7	0.	1.0000	0.7000	1.0000	0.	0.	0.
8	0.	1.0000	0.8000	1.0000	0.	0.	0.
9	0.	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

OPTION 2

OPTION 2

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 4 FLOW INPUT DATA (GAS IS AIR, NO 1.)
 *** WILL EXECUTE OPTION NO 2 ***

FRICTION FACT AND HEAT TRANSFER CORRELATION FORMS

$$N(NUS) = A * (N(PR) ** B) * (N(RE) ** C)$$

$$F = D * (N(RE) ** E)$$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

AL= 4.230+00, BL= 0., CL= 0.
 AT= 2.050-02, BT= 4.000-01, CT= 8.000-01
 DL= 1.600+01, EL= -1.000+00, DT= 4.600-02, ET= -2.000-01

BULK TEMP FOR HEAT TRANSFER CORRELATION (0=NO, 1=YES)

LAMINAR = 0 TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.0000+03 TO 8.0000+03
 TRANSITION FOR FRICTION AT 2.3000+03

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP
INLET	2.34500+01		91.00
EXIT	0.	0.	500.00
EX/IN	0.		0.
PSEX/PTIN = 0.			
WEIGHT FLOW = 10.00000-03		HEAT RELEASE = 0.	
QBAR = 0.		Q/QBAR = 0.	
MAX WALL TEMP = 1237.92 AT STAGE NO 0			

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS	MACH NO	WALL TEMP(DEG)
10.000-05	10.000-05	0.05

COUNTER LIMITS ON ITERATIONS

OPTION ITERATION = 15
 CHOKES/WT FLOW = 10 CHOKES/CASE = 30
 STAGE PRESS AND WALL TEMP = 40

OPTION 2

OPTION 2

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 4 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 4.78204-02 MAX AVE WALL TEMP = 1237.92 AT STAGE 10
HEAT ADDITION = 4.7729+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.2008+00	0.2778	9.59446+03
EXIT	16.834	15.943	500.0	2.8231+00	0.5060	7.88038+04
IN-EX	6.6160+00		-409.00			
RATIO	0.71787		1.7423	PSEX/PTIN = 0.67986		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	9.0057-01	22.549(AFTER)
EXIT	7.5000-01	2.1173+00	18.951(BEFORE)

CASE 4 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.30	0.	132.5	1084.4	0.3060	1.12131+05
2	22.03	0.	173.8	1087.6	0.3224	1.06657+05
3	21.74	0.	215.1	1096.1	0.3396	1.01797+05
4	21.43	0.	256.2	1108.9	0.3577	9.74547+04
5	21.09	0.	297.2	1125.0	0.3770	9.35527+04
6	20.73	0.	338.1	1143.9	0.3977	9.00285+04
7	20.34	0.	378.8	1164.9	0.4202	8.68307+04
8	19.92	0.	419.3	1187.8	0.4452	8.39167+04
9	19.46	0.	459.7	1212.2	0.4734	8.12511+04
10	18.95	0.	500.0	1237.9	0.5060	7.88038+04

OPTION 2

OPTION 2

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 4 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	1.3689+00	20.90	0.	1.0640-04	4.4959-03	2.4355-01
2	1.4899+00	20.50	0.	1.1084-04	4.5411-03	2.4355-01
3	1.6171+00	20.07	0.	1.1496-04	4.5836-03	2.4355-01
4	1.7513+00	19.62	0.	1.1878-04	4.6238-03	2.4355-01
5	1.8939+00	19.13	0.	1.2235-04	4.6617-03	2.4355-01
6	2.0467+00	18.60	0.	1.2569-04	4.6977-03	2.4355-01
7	2.2121+00	18.03	0.	1.2884-04	4.7318-03	2.4355-01
8	2.3931+00	17.40	0.	1.3180-04	4.7642-03	2.4355-01
9	2.5945+00	16.71	0.	1.3460-04	4.7950-03	2.4355-01
10	2.8231+00	15.94	0.	1.3725-04	4.8245-03	2.4355-01

OPTION 3

OPTION 3

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 6 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0. CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA
1	0.	3.0000+00	5.0000-01	1.9635-01
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	0.	0.	0.	0.

OPTION 3

OPTION 3

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 6 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
2	0.2000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
3	0.3000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
4	0.4000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
5	0.5000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
6	0.6000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
7	0.7000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
8	0.8000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
9	0.9000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
10	1.0000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000

OPTION 3

OPTION 3

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 6 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 0.
 INTENDED ENTRANCE LENGTH EFFECT = 0.
 BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.	1.0000	0.2000	1.0000	0.	0.	0.
3	0.	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	1.0000	0.6000	1.0000	0.	0.	0.
7	0.	1.0000	0.7000	1.0000	0.	0.	0.
8	0.	1.0000	0.8000	1.0000	0.	0.	0.
9	0.	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

OPTION 3

OPTION 3

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 6 FLOW INPUT DATA (GAS IS AIR ,NO 1.)
 *** WILL EXECUTE OPTION NO 3 ***

FRICTION FACT AND HEAT TRANSFER CORRELATION FORMS

$N(NU) = A * (N(PR) ** B) * (N(RE) ** C)$

$F = D * (N(RE) ** E)$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

AL= 4.230+00, BL= 0., CL= 0.
 AT= 2.050-02, BT= 4.000-01, CT= 8.000-01
 DL= 1.600+01, EL= -1.000+00, DT= 4.600-02, ET= -2.000-01

BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)

LAMINAR = 0 TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.0000+03 TO 8.0000+03
 TRANSITION FOR FRICTION AT 2.3000+03

	TOTAL PRESS	STATIC PRESS.	TOTAL TEMP
INLET	2.34500+01		91.00
EXIT	0.	1.59510+01	0.
EX/IN	0.		0.

PSEX/PTIN = 0.
 WEIGHT FLOW = 10.00000-03 HEAT RELEASE = 4.77150+00
 QBAR = 0. Q/QBAR = 0.
 MAX WALL TEMP = 0. AT STAGE NO 0

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS	MACH NO	WALL TEMP(DEG)
10.000-05	10.000-05	0.05

COUNTER LIMITS ON ITERATIONS

OPTION ITERATION = 15
 CHOKES/WT FLOW = 10 CHOKES/CASE = 30
 STAGE PRESS AND WALL TEMP = 40

OPTION 3

OPTION 3

*** GENERAL FLOW PASSAGE (ANP 663) ***
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 6 FLOW AND TEMPERATURE RESULTS (GAS IS AIR, NO 1)

WEIGHT FLOW = 4.78052-02 MAX AVE WALL TEMP = 1237.90 AT STAGE 10
 HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.2000+00	0.2777	9.59142+03
EXIT	16.840	15.950	500.0	2.8203+00	0.5056	7.87781+04
IN-EX	6.6101+00		-409.01			
RATIO	0.71812		1.7423	PSEX/PTIN = 0.68016		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	8.9997-01	22.550(AFTER)
EXIT	7.5000-01	2.1152+00	18.955(BEFORE)

CASE 6 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.30	0.	132.5	1084.3	0.3059	1.12096+05
2	22.03	0.	173.8	1087.5	0.3223	1.06623+05
3	21.74	0.	215.1	1096.1	0.3395	1.01765+05
4	21.43	0.	256.2	1108.9	0.3576	9.74233+04
5	21.09	0.	297.2	1125.0	0.3768	9.35225+04
6	20.73	0.	338.1	1143.8	0.3975	8.99994+04
7	20.34	0.	378.8	1164.9	0.4200	8.68025+04
8	19.92	0.	419.3	1187.8	0.4449	8.38894+04
9	19.46	0.	459.8	1212.2	0.4731	8.12246+04
10	18.96	0.	500.0	1237.9	0.5056	7.87781+04

OPTION 4

OPTION 4

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 8 FLOW INPUT DATA (GAS IS AIR ,NO 1.)
 *** WILL EXECUTE OPTION NO 4 ***

FRICITION FACT AND HEAT TRANSFER CORRELATION FORMS

$$N(NUS)=A*(N(PR)**B)*(N(RE)**C)$$

$$F=D*(N(RE)**E)$$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

AL= 4.230+00, BL= 0., CL= 0.

AT= 2.050-02, BT= 4.000-01, CT= 8.000-01

DL= 1.600+01, EL= -1.000+00, DT= 4.600-02, ET= -2.000-01

BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)

LAMINAR = 0 TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.0000+03 TO 8.0000+03

TRANSITION FOR FRICITION AT 2.3000+03

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP
INLET	2.34500+01		91.00
EXIT	0.	1.59510+01	500.00
EX/IN	0.		0.

PSEX/PTIN = 0.

WEIGHT FLOW = 10.00000-03 HEAT RELEASE = 0.

QBAR = 0. Q/QBAR = 0.

MAX WALL TEMP = 0. AT STAGE NO 0

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS	MACH NO	WALL TEMP(DEG)
10.000-05	10.000-05	0.05

COUNTER LIMITS ON ITERATIONS

OPTION ITERATION = 15

CHOKES/WT FLOW = 10 CHOKES/CASE = 30

STAGE PRESS AND WALL TEMP = 40

OPTION 4

OPTION 4

*** GENERAL FLOW PASSAGE (ANP 663) ***
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 8 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 4.78015-02 MAX AVE WALL TEMP = 1237.85 AT STAGE 10
 HEAT ADDITION = 4.7710+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.1998+00	0.2777	9.59066+03
EXIT	16.842	15.952	500.0	2.8195+00	0.5055	7.87726+04
IN-EX	6.6085+00		-409.00			
RATIO	0.71819		1.7423	PSEX/PTIN = 0.68024		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	8.9982-01	22.550(AFTER)
EXIT	7.5000-01	2.1146+00	18.956(BEFORE)

OPTION 5

OPTION 5

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 10 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0.

CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA
1	0.	3.0000+00	5.0000-01	1.9635-01
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	0.	0.	0.	0.

OPTION 5

OPTION 5

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 10 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
2	0.2000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
3	0.3000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
4	0.4000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
5	0.5000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
6	0.6000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
7	0.7000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
8	0.8000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
9	0.9000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
10	1.0000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000

OPTION 5

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OPTION 5

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 10 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 0.
 INTENDED ENTRANCE LENGTH EFFECT = 0.
 BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.	1.0000	0.2000	1.0000	0.	0.	0.
3	0.	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	1.0000	0.6000	1.0000	0.	0.	0.
7	0.	1.0000	0.7000	1.0000	0.	0.	0.
8	0.	1.0000	0.8000	1.0000	0.	0.	0.
9	0.	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

OPTION 5

OPTION 5

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 10 FLOW INPUT DATA (GAS IS AIR ,NO 1.)
 *** WILL EXECUTE OPTION NO 5 ***

FRICITION FACT AND HEAT TRANSFER CORRELATION FORMS

$N(NUS) = A * (N(PR) ** B) * (N(RE) ** C)$

$F = D * (N(RE) ** E)$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

AL= 4.230+00, BL= 0., CL= 0.
 AT= 2.050-02, BT= 4.000-01, CT= 8.000-01
 DL= 1.600+01, EL= -1.000+00, DT= 4.600-02, ET= -2.000-01

BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)

LAMINAR = 0 TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.0000+03 TO 8.0000+03
 TRANSITION FOR FRICTION AT 2.3000+03

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP
INLET	2.34500+01		91.00
EXIT	1.68410+01	0.	0.
EX/IN	0.		0.
PSEX/PTIN = 0.			
WEIGHT FLOW = 10.00000-03		HEAT RELEASE = 4.77150+00	
QBAR = 0.		Q/QBAR = 0.	
MAX WALL TEMP = 0.		AT STAGE NO 0	

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS MACH NO WALL TEMP(DEG)
 10.000-05 10.000-05 0.05

COUNTER LIMITS ON ITERATIONS

OPTION ITERATION = 15
 CHOKES/WT FLOW = 10 CHOKES/CASE = 30
 STAGE PRESS AND WALL TEMP = 40

OPTION 5

OPTION 5

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 10 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 4.78022-02 MAX AVE WALL TEMP = 1237.96 AT STAGE 10
HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.1998+00	0.2777	9.59081+03
EXIT	16.841	15.951	500.0	2.8198+00	0.5056	7.87717+04
IN-EX	6.6092+00		-409.04			
RATIO	0.71816		1.7424	PSEX/PTIN = 0.68021		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	8.9985-01	22.550(AFTER)
EXIT	7.5000-01	2.1149+00	18.956(BEFORE)

CASE 10 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.30	0.	132.5	1084.4	0.3058	1.12088+05
2	22.03	0.	173.8	1087.6	0.3223	1.06616+05
3	21.74	0.	215.1	1096.2	0.3395	1.01757+05
4	21.43	0.	256.2	1108.9	0.3575	9.74163+04
5	21.09	0.	297.2	1125.0	0.3767	9.35155+04
6	20.73	0.	338.1	1143.9	0.3974	8.99925+04
7	20.34	0.	378.8	1164.9	0.4200	8.67958+04
8	19.92	0.	419.4	1187.8	0.4449	8.38828+04
9	19.46	0.	459.8	1212.3	0.4730	8.12181+04
10	18.96	0.	500.0	1238.0	0.5056	7.87717+04

OPTION 6

RINGS

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 28 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0.

CROSS SECTION IS CONC. RINGS

STGE	X/L	LENGTH	OUTER DIAM	INNER DIAM	RING THICK	NO RINGS
1	0.	3.0000+00	2.8530+00	3.8200-01	2.3585-02	12
2	0.	0.	0.	0.	0.	0
3	0.	0.	0.	0.	0.	0
4	0.	0.	0.	0.	0.	0
5	0.	0.	0.	0.	0.	0
6	0.	0.	0.	0.	0.	0
7	0.	0.	0.	0.	0.	0
8	0.	0.	0.	0.	0.	0
9	0.	0.	0.	0.	0.	0
10	0.	0.	0.	0.	0.	0

RINGS

RINGS

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 28 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS ELLIPTICAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	1.77466-01	2.70541+00	1.0000	1.0000
2	0.2000	3.00000+00	1.77466-01	2.70541+00	1.0000	1.0000
3	0.3000	3.00000+00	1.77466-01	2.70541+00	1.0000	1.0000
4	0.4000	3.00000+00	1.77466-01	2.70541+00	1.0000	1.0000
5	0.5000	3.00000+00	1.77466-01	2.70541+00	1.0000	1.0000
6	0.6000	3.00000+00	1.77466-01	2.70541+00	1.0000	1.0000
7	0.7000	3.00000+00	1.77466-01	2.70541+00	1.0000	1.0000
8	0.8000	3.00000+00	1.77466-01	2.70541+00	1.0000	1.0000
9	0.9000	3.00000+00	1.77466-01	2.70541+00	1.0000	1.0000
10	1.0000	3.00000+00	1.77466-01	2.70541+00	1.0000	1.0000

RINGS

66

RINGS

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 28 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 0.
 INTENDED ENTRANCE LENGTH EFFECT = 0.
 BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.	1.0000	0.2000	1.0000	0.	0.	0.
3	0.	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	1.0000	0.6000	1.0000	0.	0.	0.
7	0.	1.0000	0.7000	1.0000	0.	0.	0.
8	0.	1.0000	0.8000	1.0000	0.	0.	0.
9	0.	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

RINGS

RINGS

*** GENERAL FLOW PASSAGE (ANP 663) ***
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 28 FLOW INPUT DATA (GAS IS AIR ,NO 1.)
*** WILL EXECUTE OPTION NO 11 ***

FRICTION FACT AND HEAT TRANSFER CORRELATION FORMS

$N(NUS) = A * (N(PR)**B) * (N(RE)**C)$

$F = D * (N(RE)**E)$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

AL= 4.230+00, BL= 0., CL= 0.

AT= 2.050-02, BT= 4.000-01, CT= 8.000-01

DL= 1.600+01, EL= -1.000+00, DT= 4.600-02, ET= -2.000-01

BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)

LAMINAR = 0 TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.0000+03 TO 8.0000+03

TRANSITION FOR FRICTION AT 2.3000+03

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP
INLET	2.34500+01		91.00
EXIT	0.	0.	500.00
EX/IN	0.		0.

PSEX/PTIN = 0.

WEIGHT FLOW = 2.50000-01 HEAT RELEASE = 4.77150+00

QBAR = 0. Q/QBAR = 0.

MAX WALL TEMP = 0. AT STAGE NO 0

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS	MACH NO	WALL TEMP(DEG)
10.000-05	10.000-05	0.05

COUNTER LIMITS ON ITERATIONS

OPTION ITERATION = 15

CHOKES/WT FLOW = 10 CHOKES/CASE = 30

STAGE PRESS AND WALL TEMP = 40

RINGS

RINGS

*** GENERAL FLOW PASSAGE (ANP 663) ***
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 28 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 2.50000-01 MAX AVE WALL TEMP = 201.67 AT STAGE 1
 HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLD NO
INLET	23.450		91.0	1.6723-01	0.1013	1.29209+0
EXIT	22.305	22.254	170.2	2.0000-01	0.1134	1.41478+0
IN-EX	1.1453+00		-79.21			
RATIO	0.95116		1.1438	PSEX/PTIN = 0.94900		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	1.2542-01	23.325(AFTER)
EXIT	7.5000-01	1.5000-01	22.455(BEFORE)

CASE 28 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	23.24	0.	98.9	131.4	0.1029	1.54257+04
2	23.16	0.	106.9	139.2	0.1040	1.52698+04
3	23.08	0.	114.8	147.0	0.1052	1.51177+04
4	23.00	0.	122.7	154.8	0.1063	1.49692+04
5	22.91	0.	130.7	162.6	0.1075	1.48243+04
6	22.82	0.	138.6	170.5	0.1086	1.46827+04
7	22.73	0.	146.5	178.3	0.1098	1.45443+04
8	22.64	0.	154.4	186.1	0.1110	1.44091+04
9	22.55	0.	162.3	193.9	0.1122	1.42770+04
10	22.45	0.	170.2	201.7	0.1134	1.41478+04

RINGS

RINGS

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 28 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	1.7116-01	23.07	0.	8.0367-05	6.6851-03	9.2408-02
2	1.7422-01	22.99	0.	8.0670-05	6.6987-03	9.2408-02
3	1.7731-01	22.90	0.	8.0968-05	6.7121-03	9.2408-02
4	1.8044-01	22.82	0.	8.1260-05	6.7254-03	9.2408-02
5	1.8360-01	22.73	0.	8.1547-05	6.7385-03	9.2408-02
6	1.8680-01	22.64	0.	8.1830-05	6.7514-03	9.2408-02
7	1.9004-01	22.54	0.	8.2108-05	6.7642-03	9.2408-02
8	1.9332-01	22.45	0.	8.2381-05	6.7769-03	9.2408-02
9	1.9664-01	22.35	0.	8.2650-05	6.7894-03	9.2408-02
10	2.0000-01	22.25	0.	8.2915-05	6.8017-03	9.2408-02

RECTANGULAR

RECTANGULAR

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 30 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0. CROSS SECTION IS RECTANGULAR

STGE	X/L	LENGTH	WIDTH	HEIGHT
1	0.	3.0000+00	2.0000-01	2.5000-01
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	0.	0.	0.	0.

RECTANGULAR

RECTANGULAR

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 30 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS ROUND

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
2	0.2000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
3	0.3000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
4	0.4000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
5	0.5000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
6	0.6000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
7	0.7000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
8	0.8000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
9	0.9000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
10	1.0000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000

RECTANGULAR

RECTANGULAR

*** GENERAL FLOW PASSAGE (ANP 663) ***
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 30 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 0.
INTENDED ENTRANCE LENGTH EFFECT = 0.
BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.	1.0000	0.2000	1.0000	0.	0.	0.
3	0.	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	1.0000	0.6000	1.0000	0.	0.	0.
7	0.	1.0000	0.7000	1.0000	0.	0.	0.
8	0.	1.0000	0.8000	1.0000	0.	0.	0.
9	0.	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

RECTANGULAR

RECTANGULAR

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.
 CASE 30 FLOW INPUT DATA (GAS IS AIR ,NO 1.)
 *** WILL EXECUTE OPTION NO 11 ***

FRICTION FACT AND HEAT TRANSFER CORRELATION FORMS

$$N(NUS)=A*(N(PR)**B)*(N(RE)**C)$$

$$F=D*(N(RE)**E)$$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

$$AL= 4.230+00, BL= 0., CL= 0.$$

$$AT= 2.050-02, BT= 4.000-01, CT= 8.000-01$$

$$DL= 1.600+01, EL= -1.000+00, DT= 4.600-02, ET= -2.000-01$$

BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)

LAMINAR = 0 TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.0000+03 TO 8.0000+03

TRANSITION FOR FRICTION AT 2.3000+03

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP
INLET	2.34500+01		91.00
EXIT	0.	0.	500.00
EX/IN	0.		0.

$$PSEX/PTIN = 0.$$

$$WEIGHT \text{ FLOW} = 10.00000-03 \quad \text{HEAT RELEASE} = 4.77150+00$$

$$QBAR = 0. \quad Q/QBAR = 0.$$

$$MAX \text{ WALL TEMP} = 0. \quad \text{AT STAGE NO } 0$$

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS	MACH NO	WALL TEMP(DEG)
10.000-05	10.000-05	0.05

COUNTER LIMITS ON ITERATIONS

$$\text{OPTION ITERATION} = 15$$

$$\text{CHOKES/WT FLOW} = 10 \quad \text{CHOKES/CASE} = 30$$

$$\text{STAGE PRESS AND WALL TEMP} = 40$$

 * CALCULATION TERMINATED BY TYPE 160 ERROR AT LOC 1 * * *

RECTANGULAR

RECTANGULAR

*** GENERAL FLOW PASSAGE (ANP 663) ***
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

 * CHOKED OCCURRED IN STAGE 6. IGNORE *
 * ALL RESULTS THERE AND DOWNSTREAM. *

CASE 30 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 10.00000-03 MAX AVE WALL TEMP = 2878.05 AT STAGE 10
 HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	7.9912-01	0.2245	3.50175+03
EXIT	22.305	22.254	1911.3	2.0000-01	0.1134	1.63399+04
IN-EX	1.1453+00		-1820.31			
RATIO	0.95116		4.3037	PSEX/PTIN = 0.94900		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	5.9934-01	22.851(AFTER)
EXIT	7.5000-01	1.5000-01	22.455(BEFORE)

CASE 30 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.22	0.	288.2	1875.9	0.2815	3.73517+04
2	21.44	0.	482.4	1876.3	0.3349	3.09774+04
3	20.46	0.	672.9	1945.8	0.3964	2.68618+04
4	19.21	0.	859.7	2049.3	0.4758	2.39958+04
5	17.52	0.	1042.7	2170.9	0.6031	2.18890+04
6	15.59	0.	1222.3	2302.4	1.0159	2.02744+04
7	22.73	0.	1398.6	2439.1	0.1098	1.89951+04
8	22.64	0.	1571.9	2583.0	0.1110	1.79526+04
9	22.55	0.	1742.7	2729.7	0.1122	1.70823+04
10	22.45	0.	1911.3	2878.1	0.1134	1.63399+04

RECTANGULAR

RECTANGULAR

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 30 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	1.1615+00	21.04	0.	1.1131-04	5.6014-03	2.0000-01
2	1.5412+00	19.85	0.	1.2678-04	5.8150-03	2.0000-01
3	1.9846+00	18.39	0.	1.3883-04	5.9832-03	2.0000-01
4	2.5454+00	16.52	0.	1.4855-04	6.1197-03	2.0000-01
5	3.3927+00	13.81	0.	1.5665-04	6.2332-03	2.0000-01
6	1.8680-01	8.24	0.	1.6361-04	6.3295-03	2.0000-01
7	1.9004-01	22.55	0.	1.6984-04	0.	2.0000-01
8	1.9332-01	22.46	0.	1.7479-04	0.	2.0000-01
9	1.9664-01	22.36	0.	1.7905-04	0.	2.0000-01
10	2.0000-01	22.27	0.	1.8280-04	0.	2.0000-01

RECTANGULAR

RECTANGULAR

*** GENERAL FLOW PASSAGE (ANP 663) ***
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 32 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0. CROSS SECTION IS RECTANGULAR

STGE	X/L	LENGTH	WIDTH	HEIGHT
1	0.	3.0000+00	2.0000-01	2.5000-01
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	0.	0.	0.	0.

RECTANGULAR

RECTANGULAR

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 32 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS ROUND

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
2	0.2000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
3	0.3000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
4	0.4000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
5	0.5000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
6	0.6000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
7	0.7000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
8	0.8000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
9	0.9000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000
10	1.0000	3.00000+00	2.22222-01	5.00000-02	1.0000	1.0000

RECTANGULAR

RECTANGULAR

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 32 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 0.
 INTENDED ENTRANCE LENGTH EFFECT = 0.
 BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.	1.0000	0.2000	1.0000	0.	0.	0.
3	0.	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	1.0000	0.6000	1.0000	0.	0.	0.
7	0.	1.0000	0.7000	1.0000	0.	0.	0.
8	0.	1.0000	0.8000	1.0000	0.	0.	0.
9	0.	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

RECTANGULAR

RECTANGULAR

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 32 FLOW INPUT DATA (GAS IS AIR ,NO 1.)
 *** WILL EXECUTE OPTION NO 11 ***

FRICTION FACT AND HEAT TRANSFER CORRELATION FORMS

$N(NU) = A * (N(PR) ** B) * (N(RE) ** C)$

$F = D * (N(RE) ** E)$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

AL= 4.230+00, BL= 0., CL= 0.
 AT= 2.050-02, BT= 4.000-01, CT= 8.000-01
 DL= 1.600+01, EL= -1.000+00, DT= 4.600-02, ET= -2.000-01

BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)

LAMINAR = 0 TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.0000+03 TO 8.0000+03
 TRANSITION FOR FRICTION AT 2.3000+03

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP
INLET	2.34500+01		91.00
EXIT	0.	0.	500.00
EX/IN	0.		0.
PSEX/PTIN = 0.			
WEIGHT FLOW = 5.00000-03		HEAT RELEASE = 4.77150+00	
QBAR = 0.		Q/QBAR = 0.	
MAX WALL TEMP = 0.		AT STAGE NO 0	

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS	MACH NO	WALL TEMP(DEG)
10.000-05	10.000-05	0.05

COUNTER LIMITS ON ITERATIONS

OPTION ITERATION = 15
 CHOKES/WT FLOW = 10 CHOKES/CASE = 30
 STAGE PRESS AND WALL TEMP = 40

RECTANGULAR

RECTANGULAR

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 32 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 11)

WEIGHT FLOW = 5.00000-03 MAX AVE WALL TEMP = 3617.09 AT STAGE 5
HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.9601-01	0.1097	1.75088+03
EXIT	15.719	15.070	3531.6	2.1258+00	0.4645	7.13752+03
IN-EX	7.7314+00		-3440.58			
RATIO	0.67030		7.2442			

PSEX/PTIN = 0.64263

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	1.4701-01	23.303(AFTER)
EXIT	7.5000-01	1.5943+00	17.313(BEFORE)

CASE 32 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	23.06	0.	482.4	3247.3	0.1476	1.69098+04
2	22.76	0.	859.7	3157.8	0.1795	1.26660+04
3	22.40	0.	1222.3	3280.8	0.2089	1.05217+04
4	21.97	0.	1571.9	3455.3	0.2370	9.22771+03
5	21.46	0.	1911.3	3617.1	0.2651	8.35045+03
6	20.86	0.	2243.1	1842.4	0.2945	7.70127+03
7	20.17	0.	2569.6	1979.1	0.3266	7.18544+03
8	19.37	0.	2892.6	2123.0	0.3630	7.13752+03
9	18.43	0.	3213.2	2269.7	0.4070	7.13752+03
10	17.31	0.	3531.6	2418.1	0.4645	7.13752+03

RECTANGULAR

RECTANGULAR

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 32 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	3.4251-01	22.72	0.	6.3915-05	6.5634-03	10.0000-02
2	4.8849-01	22.27	0.	7.6898-05	6.9539-03	10.0000-02
3	6.3641-01	21.76	0.	8.5847-05	7.2167-03	10.0000-02
4	7.8874-01	21.17	0.	9.3831-05	7.4086-03	10.0000-02
5	9.4890-01	20.49	0.	1.0360-04	7.5582-03	10.0000-02
6	1.1215+00	19.72	0.	0.	7.6815-03	10.0000-02
7	1.3130+00	18.82	0.	0.	7.7887-03	10.0000-02
8	1.5319+00	17.79	0.	0.	7.7992-03	10.0000-02
9	1.7933+00	16.56	0.	0.	7.7992-03	10.0000-02
10	2.1258+00	15.07	0.	0.	7.7992-03	10.0000-02

ELLIPTICAL

ELLIPTICAL

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 34 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0.

CROSS SECTION IS ELLIPTICAL

STGE	X/L	LENGTH	MAJOR AXIS	MINOR AXIS
1	0.	3.0000+00	6.0000-01	4.0000-01
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	0.	0.	0.	0.

ELLIPTICAL

ELLIPTICAL

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 34 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS RECTANGULAR

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	4.70679-01	1.88496-01	1.0000	1.0000
2	0.2000	3.00000+00	4.70679-01	1.88496-01	1.0000	1.0000
3	0.3000	3.00000+00	4.70679-01	1.88496-01	1.0000	1.0000
4	0.4000	3.00000+00	4.70679-01	1.88496-01	1.0000	1.0000
5	0.5000	3.00000+00	4.70679-01	1.88496-01	1.0000	1.0000
6	0.6000	3.00000+00	4.70679-01	1.88496-01	1.0000	1.0000
7	0.7000	3.00000+00	4.70679-01	1.88496-01	1.0000	1.0000
8	0.8000	3.00000+00	4.70679-01	1.88496-01	1.0000	1.0000
9	0.9000	3.00000+00	4.70679-01	1.88496-01	1.0000	1.0000
10	1.0000	3.00000+00	4.70679-01	1.88496-01	1.0000	1.0000

ELLIPTICAL

ELLIPTICAL

*** GENERAL FLOW PASSAGE (ANP 663) ***
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 34 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 0.
INTENDED ENTRANCE LENGTH EFFECT = 0.
BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.	1.0000	0.2000	1.0000	0.	0.	0.
3	0.	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	1.0000	0.6000	1.0000	0.	0.	0.
7	0.	1.0000	0.7000	1.0000	0.	0.	0.
8	0.	1.0000	0.8000	1.0000	0.	0.	0.
9	0.	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

ELLIPTICAL

ELLIPTICAL

*** GENERAL FLOW PASSAGE (ANP 663) ***
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 34 FLOW INPUT DATA (GAS IS AIR, NO 1.)
*** WILL EXECUTE OPTION NO 11 ***

FRICITION FACT AND HEAT TRANSFER CORRELATION FORMS

$N(NUS) = A * (N(PR) ** B) * (N(RE) ** C)$

$F = D * (N(RE) ** E)$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

AL= 4.230+00, BL= 0., CL= 0.

AT= 2.050-02, BT= 4.000-01, CT= 8.000-01

DL= 1.600+01, EL= -1.000+00, DT= 4.600-02, ET= -2.000-01

BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)

LAMINAR = 0. TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.4760+03 TO 8.0000+03
TRANSITION FOR FRICTION AT 2.3000+03

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP
INLET	2.34500+01		91.00
EXIT	0.	0.	500.00
EX/IN	0.		0.
PSEX/PTIN = 0.			
WEIGHT FLOW = 4.78042-02		HEAT RELEASE = 4.77150+00	
QBAR = 0.		Q/QBAR = 0.	
MAX WALL TEMP = 0.		AT STAGE NO 0	

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS	MACH NO	WALL TEMP(DEG)
10.000-05	10.000-05	0.05

COUNTER LIMITS ON ITERATIONS

OPTION ITERATION = 15

CHOKES/WT FLOW = 10 CHOKES/CASE = 30

STAGE PRESS AND WALL TEMP = 40

ELLIPTICAL

ELLIPTICAL

*** GENERAL FLOW PASSAGE (ANP 663) ***
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 34 FLOW AND TEMPERATURE RESULTS (GAS IS AIR, NO 1)

WEIGHT FLOW = 4.78042-02 MAX AVE WALL TEMP = 1184.02 AT STAGE 10
 HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.3067+00	0.2905	9.40496+01
EXIT	15.685	14.579	500.0	3.3044+00	0.5725	7.72461+04
IN-EX	7.7653+00		-409.02			
RATIO	0.66886		1.7423	PSEX/PTIN = 0.62169		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	9.7999-01	22.470(AFTER)
EXIT	7.5000-01	2.4783+00	18.163(BEFORE)

CASE 34 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.18	0.	132.5	1006.4	0.3222	1.09916+05
2	21.87	0.	173.8	1014.2	0.3406	1.04550+05
3	21.54	0.	215.1	1026.6	0.3600	9.97860+04
4	21.17	0.	256.2	1042.6	0.3807	9.55291+04
5	20.78	0.	297.2	1061.5	0.4032	9.17041+04
6	20.35	0.	338.1	1082.7	0.4279	8.82494+04
7	19.89	0.	378.8	1105.9	0.4557	8.51147+04
8	19.37	0.	419.4	1130.7	0.4875	8.22582+04
9	18.80	0.	459.8	1156.8	0.5253	7.96451+04
10	18.16	0.	500.0	1184.0	0.5725	7.72461+04

ELLIPTICAL

ELLIPTICAL

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 34 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	1.4996+00	20.64	0.	1.1361-04	4.5138-03	2.5361-01
2	1.6368+00	20.19	0.	1.1815-04	4.5592-03	2.5361-01
3	1.7823+00	19.69	0.	1.2236-04	4.6020-03	2.5361-01
4	1.9377+00	19.16	0.	1.2626-04	4.6423-03	2.5361-01
5	2.1053+00	18.59	0.	1.2991-04	4.6804-03	2.5361-01
6	2.2881+00	17.96	0.	1.3333-04	4.7165-03	2.5361-01
7	2.4905+00	17.26	0.	1.3654-04	4.7507-03	2.5361-01
8	2.7190+00	16.49	0.	1.3957-04	4.7832-03	2.5361-01
9	2.9840+00	15.61	0.	1.4244-04	4.8142-03	2.5361-01
10	3.3044+00	14.58	0.	1.4516-04	4.8438-03	2.5361-01

INTERSTAGE LOSSES

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INTERSTAGE LOSSES

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 36 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0.

CROSS SECTION IS ROUND

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA
1	0.	3.0000+00	5.0000-01	0.
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	0.	0.	0.	0.

INTERSTAGE LOSSES

INTERSTAGE LOSSES

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 36 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
2	0.2000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
3	0.3000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
4	0.4000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
5	0.5000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
6	0.6000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
7	0.7000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
8	0.8000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
9	0.9000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
10	1.0000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000

INTERSTAGE LOSSES

INTERSTAGE LOSSES

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 36 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 0.
 INTENDED ENTRANCE LENGTH EFFECT = 0.
 BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.5000	1.0000	0.2000	1.0000	0.	0.	0.
3	0.5000	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	1.0000	0.6000	1.0000	0.	0.	0.
7	0.7500	1.0000	0.7000	1.0000	0.	0.	0.
8	0.7500	1.0000	0.8000	1.0000	0.	0.	0.
9	0.7500	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

INTERSTAGE LOSSES

INTERSTAGE LOSSES

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 36 FLOW INPUT DATA (GAS IS AIR ,NO 1.)
 *** WILL EXECUTE OPTION NO 11 ***

FRICTION FACT AND HEAT TRANSFER CORRELATION FORMS

$N(NUS) = A * (N(PR) ** B) * (N(RE) ** C)$

$F = D * (N(RE) ** E)$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

AL= 4.230+00, BL= 0., CL= 0.

AT= 2.050-02, BT= 4.000-01, CT= 8.000-01

DL= 1.600+01, EL= -1.000+00, DT= 4.600-02, ET= -2.000-01

BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)

LAMINAR = 0 TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.4760+03 TO 8.0000+03

TRANSITION FOR FRICTION AT 2.3000+03

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP
INLET	2.34500+01		91.00
EXIT	0.	0.	500.00
EX/IN	0.		0.
PSEX/PTIN = 0.			
WEIGHT FLOW = 3.00000-02		HEAT RELEASE = 4.77150+00	
QBAR = 0.		Q/QBAR = 0.	
MAX WALL TEMP = 0.		AT STAGE NO 0	

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS	MACH NO	WALL TEMP(DEG)
10.000-05	10.000-05	0.05

COUNTER LIMITS ON ITERATIONS

OPTION ITERATION = 15

CHOKES/WT FLOW = 10 CHOKES/CASE = 30

STAGE PRESS AND WALL TEMP = 40

INTERSTAGE LOSSES

INTERSTAGE LOSSES

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 36 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 3.00000-02 MAX AVE WALL TEMP = 1770.09 AT STAGE 10
HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	4.6137-01	0.1693	6.01906+03
EXIT	17.372	17.000	735.6	1.3332+00	0.3385	4.27016+04
IN-EX	6.0780+00		-644.59			
RATIO	0.74081		2.1699	PSEX/PTIN = 0.72495		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	3.4603-01	23.104(AFTER)
EXIT	7.5000-01	9.9987-01	18.372(BEFORE)

CASE 36 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.99	0.	157.0	1685.7	0.1834	6.92835+04
2	22.86	0.29460	222.8	1644.0	0.1947	6.41813+04
3	22.43	0.32999	288.2	1625.2	0.2086	5.99230+04
4	21.95	0.	353.3	1622.3	0.2233	5.63182+04
5	21.78	0.	418.0	1631.0	0.2347	5.32294+04
6	21.61	0.	482.4	1648.3	0.2462	5.05549+04
7	21.43	0.70458	546.3	1672.1	0.2578	4.82180+04
8	20.52	0.78674	609.8	1701.1	0.2799	4.61593+04
9	19.51	0.88305	672.9	1734.0	0.3061	4.43328+04
10	18.37	0.	735.6	1770.1	0.3385	4.27016+04

INTERSTAGE LOSSES

INTERSTAGE LOSSES

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 36 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	5.2841-01	22.45	0.	6.6238-05	4.9503-03	1.5279-01
2	5.8921-01	22.26	0.	7.1243-05	5.0266-03	1.5279-01
3	6.5997-01	21.76	0.	7.5736-05	5.0961-03	1.5279-01
4	7.3540-01	21.20	0.	7.9794-05	5.1597-03	1.5279-01
5	8.0185-01	20.97	0.	8.3479-05	5.2183-03	1.5279-01
6	8.6980-01	20.73	0.	8.6846-05	5.2724-03	1.5279-01
7	9.3944-01	20.48	0.	8.9937-05	5.3225-03	1.5279-01
8	1.0490+00	19.45	0.	9.2787-05	5.3692-03	1.5279-01
9	1.1774+00	18.31	0.	9.5425-05	5.4127-03	1.5279-01
10	1.3332+00	17.00	0.	9.7877-05	5.4534-03	1.5279-01

AUTO INTERSTAGE LOSSES

AUTO INTERSTAGE LOSSES

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 38 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0.

CROSS SECTION IS ROUND

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA
1	0.	3.0000+00	4.0000-01	0.
2	0.	0.	0.	0.
3	0.	0.	5.0000-01	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	4.0000-01	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	0.	0.	0.	0.

AUTO INTERSTAGE LOSSES

AUTO INTERSTAGE LOSSES

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 38 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000
2	0.2000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000
3	0.3000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
4	0.4000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
5	0.5000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
6	0.6000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
7	0.7000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000
8	0.8000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000
9	0.9000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000
10	1.0000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000

AUTO INTERSTAGE LOSSES

AUTO INTERSTAGE LOSSES

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 38 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 1.
 INTENDED ENTRANCE LENGTH EFFECT = 0.
 BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.5000	1.0000	0.2000	1.0000	0.	0.	0.
3	0.5000	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	1.0000	0.6000	1.0000	0.	0.	0.
7	0.7500	1.0000	0.7000	1.0000	0.	0.	0.
8	0.7500	1.0000	0.8000	1.0000	0.	0.	0.
9	0.7500	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

AUTO INTERSTAGE LOSSES

AUTO INTERSTAGE LOSSES

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 38 FLOW AND TEMPERATURE RESULTS (GAS IS AIR, NO 1)

WEIGHT FLOW = 3.00000-02 MAX AVE WALL TEMP = 1648.26 AT STAGE 6
HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.1519+00	0.2718	7.52382+03
EXIT	14.283	12.766	735.6	4.0753+00	0.6829	5.33770+04
IN-EX	9.1667+00		-644.59			
RATIO	0.60909		2.1699	PSEX/PTIN = 0.54438		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	8.6390-01	22.586(AFTER)
EXIT	7.5000-01	3.0565+00	17.340(BEFORE)

CASE 38 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.24	0.	157.0	1344.6	0.3071	8.66043+04
2	21.85	0.20211	222.8	1336.0	0.3321	8.02266+04
3	21.50	0.	288.2	1625.2	0.2181	5.99230+04
4	21.35	0.	353.3	1622.3	0.2300	5.63182+04
5	21.18	0.	418.0	1631.0	0.2419	5.32294+04
6	21.01	0.43397	482.4	1648.3	0.2539	5.05549+04
7	19.94	0.	546.3	1449.9	0.4747	6.02725+04
8	19.22	0.	609.8	1488.2	0.5223	5.76992+04
9	18.37	0.	672.9	1529.1	0.5853	5.54160+04
10	17.34	0.	735.6	1572.2	0.6829	5.33770+04

AUTO INTERSTAGE LOSSES

~~AUTO INTERSTAGE LOSSES~~

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 38 MISCELLANEOUS STAGE-BY-STAGE OUTPUT						
STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	1.3740+00	20.83	0.	1.0658-04	4.7342-03	2.3873-01
2	1.5595+00	20.25	0.12960	1.1369-04	4.8072-03	2.3873-01
3	6.8964-01	20.81	0.	7.5736-05	5.0961-03	1.5279-01
4	7.5708-01	20.58	0.	7.9794-05	5.1597-03	1.5279-01
5	8.2602-01	20.34	0.	8.3479-05	5.2183-03	1.5279-01
6	8.9665-01	20.09	0.48399	8.6846-05	5.2724-03	1.5279-01
7	2.6633+00	17.12	0.	1.4007-04	5.0902-03	2.3873-01
8	3.0052+00	16.00	0.	1.4409-04	5.1348-03	2.3873-01
9	3.4400+00	14.63	0.	1.4782-04	5.1764-03	2.3873-01
10	4.0753+00	12.77	0.	1.5129-04	5.2154-03	2.3873-01

MODIFIED AUTO INTERSTAGE LOSSES

MODIFIED AUTO INTERSTAGE LOSSES

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 40 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 1.
 INTENDED ENTRANCE LENGTH EFFECT = 0.
 BETA1 = 0. BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.5000	0.7500	0.2000	1.0000	0.	0.	0.
3	0.5000	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	0.7500	0.6000	1.0000	0.	0.	0.
7	0.7500	1.0000	0.7000	1.0000	0.	0.	0.
8	0.7500	1.0000	0.8000	1.0000	0.	0.	0.
9	0.7500	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

MODIFIED AUTO INTERSTAGE LOSSES

MODIFIED AUTO INTERSTAGE LOSSES

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 40 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 3.00000-02 MAX AVE WALL TEMP = 1648.26 AT STAGE 6
HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.1519+00	0.2718	7.52382+03
EXIT	14.588	13.133	735.6	3.9774+00	0.6651	5.33770+04
IN-EX	8.8616+00		-644.59			
RATIO	0.62211		2.1699	PSEX/PTIN = 0.56006		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	8.6390-01	22.586(AFTER)
EXIT	7.5000-01	2.9830+00	17.571(BEFORE)

CASE 40 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.24	0.	157.0	1344.6	0.3071	8.66043+04
2	21.85	0.15158	222.8	1336.0	0.3321	8.02266+04
3	21.56	0.	288.2	1625.2	0.2175	5.99230+04
4	21.40	0.	353.3	1622.3	0.2294	5.63182+04
5	21.23	0.	418.0	1631.0	0.2413	5.32294+04
6	21.06	0.32462	482.4	1648.3	0.2532	5.05549+04
7	20.11	0.	546.3	1449.9	0.4693	6.02725+04
8	19.40	0.	609.8	1488.2	0.5153	5.76992+04
9	18.57	0.	672.9	1529.1	0.5753	5.54160+04
10	17.57	0.	735.6	1572.2	0.6651	5.33770+04

MODIFIED AUTO INTERSTAGE LOSSES

MODIFIED AUTO INTERSTAGE LOSSES

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 40 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	1.3740+00	20.83	0.	1.0658-04	4.7342-03	2.3873-01
2	1.5595+00	20.25	0.12960	1.1369-04	4.8072-03	2.3873-01
3	6.8793-01	20.86	0.	7.5736-05	5.0961-03	1.5279-01
4	7.5516-01	20.64	0.	7.9794-05	5.1597-03	1.5279-01
5	8.2388-01	20.40	0.	8.3479-05	5.2183-03	1.5279-01
6	8.9428-01	20.15	0.48399	8.6846-05	5.2724-03	1.5279-01
7	2.6344+00	17.33	0.	1.4007-04	5.0902-03	2.3873-01
8	2.9668+00	16.23	0.	1.4409-04	5.1348-03	2.3873-01
9	3.3846+00	14.90	0.	1.4782-04	5.1764-03	2.3873-01
10	3.9774+00	13.13	0.	1.5129-04	5.2154-03	2.3873-01

X/L STAGE LENGTH INPUT

X/L STAGE LENGTH INPUT

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 42 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS ROUND

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA
1	0.1000	0.	4.0000-01	0.
2	0.2000	0.	0.	0.
3	0.3000	0.	5.0000-01	0.
4	0.4000	0.	0.	0.
5	0.5000	0.	0.	0.
6	0.6000	0.	0.	0.
7	0.7000	0.	4.0000-01	0.
8	0.8000	0.	0.	0.
9	0.9000	0.	0.	0.
10	1.0000	0.	0.	0.

X/L STAGE LENGTH INPUT

X/L STAGE LENGTH INPUT

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 42 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000+01 CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000
2	0.2000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000
3	0.3000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
4	0.4000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
5	0.5000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
6	0.6000	3.00000+00	5.00000-01	1.96350-01	1.0000	1.0000
7	0.7000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000
8	0.8000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000
9	0.9000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000
10	1.0000	3.00000+00	4.00000-01	1.25664-01	1.0000	1.0000

X/L STAGE LENGTH INPUT

X/L STAGE LENGTH INPUT

*** GENERAL FLOW PASSAGE (ANP 663) ***

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 42 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 3.00000-02 MAX AVE WALL TEMP = 1648.26 AT STAGE 6
HEAT ADDITION = 4.7715+00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.1519+00	0.2718	7.52382+03
EXIT	14.588	13.133	735.6	3.9774+00	0.6651	5.33770+04
IN-EX	8.8616+00		-644.59			
RATIO	0.62211		2.1699	PSEX/PTIN = 0.56006		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000-01	8.6390-01	22.586(AFTER)
EXIT	7.5000-01	2.9830+00	17.571(BEFORE)

CASE 42 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.24	0.	157.0	1344.6	0.3071	8.66043+04
2	21.85	0.15158	222.8	1336.0	0.3321	8.02266+04
3	21.56	0.	288.2	1625.2	0.2175	5.99230+04
4	21.40	0.	353.3	1622.3	0.2294	5.63182+04
5	21.23	0.	418.0	1631.0	0.2413	5.32294+04
6	21.06	0.32462	482.4	1648.3	0.2532	5.05549+04
7	20.11	0.	546.3	1449.9	0.4693	6.02725+04
8	19.40	0.	609.8	1488.2	0.5153	5.76992+04
9	18.57	0.	672.9	1529.1	0.5753	5.54160+04
10	17.57	0.	735.6	1572.2	0.6651	5.33770+04

X/L STAGE LENGTH INPUT

X/L STAGE LENGTH INPUT

*** GENERAL FLOW PASSAGE (ANP 663) ***
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 42 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	1.3740+00	20.83	0.	1.0658-04	4.7342-03	2.3873-01
2	1.5595+00	20.25	0.12960	1.1369-04	4.8072-03	2.3873-01
3	6.8793-01	20.86	0.	7.5736-05	5.0961-03	1.5279-01
4	7.5516-01	20.64	0.	7.9794-05	5.1597-03	1.5279-01
5	8.2388-01	20.40	0.	8.3479-05	5.2183-03	1.5279-01
6	8.9428-01	20.15	0.48399	8.6846-05	5.2724-03	1.5279-01
7	2.6344+00	17.33	0.	1.4007-04	5.0902-03	2.3873-01
8	2.9668+00	16.23	0.	1.4409-04	5.1348-03	2.3873-01
9	3.3846+00	14.90	0.	1.4782-04	5.1764-03	2.3873-01
10	3.9774+00	13.13	0.	1.5129-04	5.2154-03	2.3873-01

X/L STAGE LENGTH INPUT

X/L STAGE LENGTH INPUT

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

SUMMARY PRINTOUT FOR 20 POINTS (GAS IS AIR , NO 1)
 (CASES 2 THRU 42)

CASE	WEIGHT FLOW	INLET P-TOT	EXIT P-TOT	PTEX/ PTIN	EXIT P-STAT	PSEX/ PTIN
2	4.78042-02	23.450	16.840	0.71813	15.950	0.68018
4	4.78204-02	23.450	16.834	0.71787	15.943	0.67986
6	4.78052-02	23.450	16.840	0.71812	15.950	0.68016
8	4.78015-02	23.450	16.842	0.71819	15.952	0.68024
10	4.78022-02	23.450	16.841	0.71816	15.951	0.68021
12	4.78020-02	23.450	16.841	0.71818	15.951	0.68023
14	4.78063-02	23.451	16.841	0.71814	15.951	0.68019
16	4.78063-02	23.451	16.841	0.71814	15.951	0.68019
18	4.78063-02	23.451	16.841	0.71814	15.951	0.68018
20	4.78063-02	23.451	16.841	0.71814	15.951	0.68019
22	4.78063-02	23.450	16.840	0.71811	15.949	0.68015
24	4.78063-02	23.450	16.840	0.71811	15.949	0.68015
26	4.78068-02	23.450	16.839	0.71810	15.949	0.68014
28	2.50000-01	23.450	22.305	0.95116	22.254	0.94900
32	5.00000-03	23.450	15.719	0.67030	15.070	0.64263
34	4.78042-02	23.450	15.685	0.66886	14.579	0.62169
36	3.00000-02	23.450	17.372	0.74081	17.000	0.72495
38	3.00000-02	23.450	14.283	0.60909	12.766	0.54438
40	3.00000-02	23.450	14.588	0.62211	13.133	0.56006
42	3.00000-02	23.450	14.588	0.62211	13.133	0.56006

X/L STAGE LENGTH INPUT

X/L STAGE LENGTH INPUT

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

SUMMARY PRINTOUT FOR 20 POINTS (GAS IS AIR , NO 1)
 (CASES 2 THRU 42)

CASE	INLET T-TOT	EXIT T-TOT	TTEX/ ITIN	HEAT ADDITION	MAX AVE SURF-TEMP AT STGE	
2	91.0	500.0	1.74233	4.77150+00	1237.9	10
4	91.0	500.0	1.74229	4.77286+00	1237.9	10
6	91.0	500.0	1.74231	4.77150+00	1237.9	10
8	91.0	500.0	1.74229	4.77097+00	1237.9	10
10	91.0	500.0	1.74236	4.77150+00	1238.0	10
12	91.0	500.0	1.74229	4.77102+00	1237.9	10
14	91.0	500.0	1.74229	4.77150+00	1237.9	10
16	91.0	500.0	1.74229	4.77145+00	1237.9	10
18	91.0	500.0	1.74229	4.77150+00	1237.9	10
20	91.0	500.0	1.74229	4.77145+00	1237.9	10
22	91.0	500.0	1.74229	4.77150+00	1237.9	10
24	91.0	500.0	1.74229	4.77145+00	1237.9	10
26	91.0	500.0	1.74229	4.77150+00	1237.9	10
28	91.0	170.2	1.14376	4.77150+00	201.7	10
32	91.0	3531.6	7.24424	4.77150+00	3617.1	5
34	91.0	500.0	1.74233	4.77150+00	1184.0	10
36	91.0	735.6	2.16985	4.77150+00	1770.1	10
38	91.0	735.6	2.16985	4.77150+00	1648.3	6
40	91.0	735.6	2.16985	4.77150+00	1648.3	6
42	91.0	735.6	2.16985	4.77150+00	1648.3	6

PARAMETRIC

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 13 ORIGINAL GEOMETRICAL INPUT DATA

TOTAL LENGTH = 0. CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA
1	0.	3.0000E 00	5.0000E-01	1.9635E-01
2	0.	0.	0.	0.
3	0.	0.	0.	0.
4	0.	0.	0.	0.
5	0.	0.	0.	0.
6	0.	0.	0.	0.
7	0.	0.	0.	0.
8	0.	0.	0.	0.
9	0.	0.	0.	0.
10	0.	0.	0.	0.

PARAMETRIC

PARAMETRIC

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 13 PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS

TOTAL LENGTH = 3.0000E 01 CROSS SECTION IS GENERAL

STGE	X/L	LENGTH	HYDR. DIAM	FLOW AREA	H- MULT	F- MULT
1	0.1000	3.00000E 00	5.00000E-01	1.96350E-01	1.0000	1.0000
2	0.2000	3.00000E 00	5.00000E-01	1.96350E-01	1.0000	1.0000
3	0.3000	3.00000E 00	5.00000E-01	1.96350E-01	1.0000	1.0000
4	0.4000	3.00000E 00	5.00000E-01	1.96350E-01	1.0000	1.0000
5	0.5000	3.00000E 00	5.00000E-01	1.96350E-01	1.0000	1.0000
6	0.6000	3.00000E 00	5.00000E-01	1.96350E-01	1.0000	1.0000
7	0.7000	3.00000E 00	5.00000E-01	1.96350E-01	1.0000	1.0000
8	0.8000	3.00000E 00	5.00000E-01	1.96350E-01	1.0000	1.0000
9	0.9000	3.00000E 00	5.00000E-01	1.96350E-01	1.0000	1.0000
10	1.0000	3.00000E 00	5.00000E-01	1.96350E-01	1.0000	1.0000

PARAMETRIC

PARAMETRIC

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 13 POWER PROFILE AND INTERSTAGE LOSS INPUT

AUTOLOSS CALC = 0.

INTENDED ENTRANCE LENGTH EFFECT = 0.

BETA1 = 0.

BETA2 = 0.

STGE	INTRSTGE LOSS COF	AUTO LOSS MULT	PHISUM	PHIEX	P0	P1	P2
1	0.	1.0000	0.1000	1.0000	0.	0.	0.
2	0.	1.0000	0.2000	1.0000	0.	0.	0.
3	0.	1.0000	0.3000	1.0000	0.	0.	0.
4	0.	1.0000	0.4000	1.0000	0.	0.	0.
5	0.	1.0000	0.5000	1.0000	0.	0.	0.
6	0.	1.0000	0.6000	1.0000	0.	0.	0.
7	0.	1.0000	0.7000	1.0000	0.	0.	0.
8	0.	1.0000	0.8000	1.0000	0.	0.	0.
9	0.	1.0000	0.9000	1.0000	0.	0.	0.
10	0.	1.0000	1.0000	1.0000	0.	0.	0.

PARAMETRIC

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PARAMETRIC

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 13 FLOW INPUT DATA (GAS IS AIR ,NO 1.)
 *** WILL EXECUTE OPTION NO 12 ***

FRICITION FACT AND HEAT TRANSFER CORRELATION FORMS

$N(NUS)=A*(N(PR)**B)*(N(RE)**C)$

$F=D*(N(RE)**E)$

NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)

AL= 4.230E 00, BL= 0., CL= 0.

AT= 2.050E-02, BT= 4.000E-01, CT= 8.000E-01

DL= 1.600E 01, EL= -1.000E 00, DT= 4.600E-02, ET= -2.000E-01

BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)

LAMINAR = 0 TURBULENT = 0

TRANSITION RANGE FOR N(NU) 2.0000E 03 TO 8.0000E 03

TRANSITION FOR FRICTION AT 2.3000E 03

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP
INLET	2.34500E 01		91.00
EXIT	0.	0.	500.00
EX/IN	0.		0.

PSEX/PTIN = 0.

WEIGHT FLOW = 4.78063E-02 HEAT RELEASE = 0.

QBAR = 0. Q/QBAR = 0.

MAX WALL TEMP = 0. AT STAGE NO 0

ACCURACIES (FRACTIONAL UNLESS NOTED)

PRESS	MACH NO	WALL TEMP(DEG)
10.000E-05	10.000E-05	0.05

COUNTER LIMITS ON ITERATIONS

OPTION ITERATION = 15

CHOKES/WT FLOW = 10 CHOKES/CASE = 30

STAGE PRESS AND WALL TEMP = 40

PARAMETRIC

PARAMETRIC

*** GENERAL FLOW PASSAGE (ANP 663) ***
 INPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE	13	PARAMETRIC SETUP (16 CASES)			
		INLET TOT PRESS	INLET TEMP	MAX AVE EXIT TEMP	MAX AVE HEAT RELEASE SURF TEMP
INCREMENT	5.0000E 00	1.0000E 02	1.0000E 02	0.	
NO OF TIMES	2	2	2	2	0
		EXIT STAT PRESS	EXIT TOT PRESS	WEIGHT FLOW	HEAT RELEASE EXIT TEMP
INCREMENT	0.	0.	-10.0000E-03	0.	
NO OF TIMES	0	0	2	2	0

PARAMETRIC

PARAMETRIC

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 13 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 4.78063E-02 MAX AVE WALL TEMP = 1237.87 AT STAGE 10
 HEAT ADDITION = 4.7715E 00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.2000E 00	0.2777	9.59163E 03
EXIT	16.840	15.949	500.0	2.8204E 00	0.5057	7.87805E 04
IN-EX	6.6104E 00		-409.00			
RATIO	0.71811		1.7423	PSEX/PTIN = 0.68015		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000E-01	9.0001E-01	22.550(AFTER)
EXIT	7.5000E-01	2.1153E 00	18.955(BEFORE)

CASE 13 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.30	0.	132.5	1084.3	0.3059	1.12098E 05
2	22.03	0.	173.8	1087.5	0.3223	1.06626E 05
3	21.74	0.	215.1	1096.1	0.3395	1.01767E 05
4	21.43	0.	256.2	1108.8	0.3576	9.74259E 04
5	21.09	0.	297.2	1125.0	0.3768	9.35251E 04
6	20.73	0.	338.1	1143.8	0.3975	9.00019E 04
7	20.34	0.	378.8	1164.9	0.4200	8.68051E 04
8	19.92	0.	419.3	1187.7	0.4449	8.38920E 04
9	19.46	0.	459.7	1212.2	0.4731	8.12271E 04
10	18.95	0.	500.0	1237.9	0.5057	7.87805E 04

PARAMETRIC

PARAMETRIC

* * * GENERAL FLOW PASSAGE (ANP 663) * * *
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 13 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	1.3680E 00	20.90	0.	1.0638E-04	4.4961E-03	2.4347E-01
2	1.4889E 00	20.50	0.	1.1082E-04	4.5414E-03	2.4347E-01
3	1.6159E 00	20.08	0.	1.1493E-04	4.5839E-03	2.4347E-01
4	1.7500E 00	19.62	0.	1.1875E-04	4.6241E-03	2.4347E-01
5	1.8925E 00	19.13	0.	1.2232E-04	4.6620E-03	2.4347E-01
6	2.0452E 00	18.60	0.	1.2567E-04	4.6979E-03	2.4347E-01
7	2.2104E 00	18.03	0.	1.2881E-04	4.7320E-03	2.4347E-01
8	2.3912E 00	17.41	0.	1.3177E-04	4.7645E-03	2.4347E-01
9	2.5922E 00	16.72	0.	1.3457E-04	4.7953E-03	2.4347E-01
10	2.8204E 00	15.95	0.	1.3722E-04	4.8247E-03	2.4347E-01

PARAMETRIC

PARAMETRIC

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 14 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 4.78063E-02 MAX AVE WALL TEMP = 1517.38 AT STAGE 10
HEAT ADDITION = 5.9651E 00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	23.450		91.0	1.2000E 00	0.2777	9.59163E 03
EXIT	15.780	14.656	600.0	3.3458E 00	0.5757	7.37017E 04
IN-EX	7.6705E 00		-509.00			
RATIO	0.67290		1.9238	PSEX/PTIN = 0.62500		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000E-01	9.0001E-01	22.550(AFTER)
EXIT	7.5000E-01	2.5093E 00	18.289(BEFORE)

CASE 14 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	22.27	0.	142.8	1411.5	0.3093	1.11377E 05
2	21.97	0.	194.5	1394.2	0.3294	1.04737E 05
3	21.64	0.	246.0	1388.9	0.3504	9.89976E 04
4	21.29	0.	297.2	1392.5	0.3727	9.39895E 04
5	20.90	0.	348.3	1403.1	0.3968	8.95837E 04
6	20.48	0.	399.1	1419.0	0.4231	8.56794E 04
7	20.01	0.	449.7	1439.1	0.4524	8.21971E 04
8	19.50	0.	500.1	1462.6	0.4861	7.90729E 04
9	18.93	0.	550.2	1488.9	0.5260	7.62552E 04
10	18.29	0.	600.0	1517.4	0.5757	7.37017E 04

PARAMETRIC

PARAMETRIC

*** GENERAL FLOW PASSAGE (ANP 663) ***
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 14 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	1.3951E 00	20.84	0.	9.9777E-05	4.5019E-03	2.4347E-01
2	1.5451E 00	20.38	0.	1.0551E-04	4.5576E-03	2.4347E-01
3	1.7037E 00	19.88	0.	1.1076E-04	4.6093E-03	2.4347E-01
4	1.8727E 00	19.35	0.	1.1557E-04	4.6574E-03	2.4347E-01
5	2.0544E 00	18.76	0.	1.2001E-04	4.7023E-03	2.4347E-01
6	2.2520E 00	18.12	0.	1.2412E-04	4.7444E-03	2.4347E-01
7	2.4703E 00	17.41	0.	1.2794E-04	4.7839E-03	2.4347E-01
8	2.7161E 00	16.62	0.	1.3151E-04	4.8212E-03	2.4347E-01
9	3.0010E 00	15.72	0.	1.3485E-04	4.8563E-03	2.4347E-01
10	3.3458E 00	14.66	0.	1.3798E-04	4.8895E-03	2.4347E-01

PARAMETRIC

PARAMETRIC

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 28 FLOW AND TEMPERATURE RESULTS (GAS IS AIR , NO 1)

WEIGHT FLOW = 3.78063E-02 MAX AVE WALL TEMP = 1275.73 AT STAGE 10
HEAT ADDITION = 3.8058E 00

	TOTAL PRESS	STATIC PRESS	TOTAL TEMP	DYNAMIC PRESS	MACH NO	REYNOLDS NO
INLET	28.450		191.0	7.1650E-01	0.1923	6.73213E 03
EXIT	25.195	24.847	600.0	1.2930E 00	0.2749	5.80994E 04
IN-EX	3.2549E 00		-409.00			
RATIO	0.88559		1.6283	PSEX/PTIN = 0.87336		

ENTRANCE AND EXIT LOSSES

	LOSS COEFF	P-TOT LOSS	TOT PRESS
INLET	7.5000E-01	5.3738E-01	27.913(AFTER)
EXIT	7.5000E-01	9.6975E-01	26.165(BEFORE)

CASE 28 STAGE-BY-STAGE OUTPUT RESULTS

STGE	EXIT P-TOT	INTRSTGE P-TO LOSS	EXIT T-TOT	EXIT T-WALL	EXIT MACH NO	AVE REYN NO
1	27.77	0.	232.6	1059.5	0.2038	7.89918E 04
2	27.63	0.	274.0	1075.8	0.2115	7.56849E 04
3	27.48	0.	315.3	1094.9	0.2191	7.27095E 04
4	27.31	0.	356.4	1116.4	0.2268	7.00188E 04
5	27.14	0.	397.4	1139.8	0.2345	6.75746E 04
6	26.97	0.	438.2	1164.7	0.2423	6.53450E 04
7	26.78	0.	478.9	1191.0	0.2502	6.33035E 04
8	26.58	0.	519.4	1218.4	0.2583	6.14277E 04
9	26.38	0.	559.8	1246.7	0.2665	5.96984E 04
10	26.16	0.	600.0	1275.7	0.2749	5.80994E 04

PARAMETRIC

PARAMETRIC

*** GENERAL FLOW PASSAGE (ANP 663) ***
 OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

CASE 28 MISCELLANEOUS STAGE-BY-STAGE OUTPUT

STGE	EXIT P-DYN	EXIT P-STAT	AUTO INTR- STG LOSS	H- COEFF	F- COEFF	MASS VELOCITY
1	7.8255E-01	26.98	0.	9.7666E-05	4.8222E-03	1.9255E-01
2	8.3504E-01	26.78	0.	1.0072E-04	4.8636E-03	1.9255E-01
3	8.8838E-01	26.58	0.	1.0358E-04	4.9027E-03	1.9255E-01
4	9.4265E-01	26.36	0.	1.0626E-04	4.9399E-03	1.9255E-01
5	9.9793E-01	26.13	0.	1.0879E-04	4.9751E-03	1.9255E-01
6	1.0543E 00	25.90	0.	1.1117E-04	5.0086E-03	1.9255E-01
7	1.1119E 00	25.65	0.	1.1342E-04	5.0405E-03	1.9255E-01
8	1.1708E 00	25.39	0.	1.1555E-04	5.0709E-03	1.9255E-01
9	1.2311E 00	25.13	0.	1.1758E-04	5.0999E-03	1.9255E-01
10	1.2930E 00	24.85	0.	1.1952E-04	5.1277E-03	1.9255E-01

PARAMETRIC

PARAMETRIC

* * * GENERAL FLOW PASSAGE (ANP 663) * * *

OUTPUT UNITS ARE INCHES, SQ. IN., PSIA, DEG F, BTU/SEC, LBM/SEC.

SUMMARY PRINTOUT FOR 17 POINTS (GAS IS AIR , NO 1)
(CASES 12 THRU 28)

CASE	WEIGHT FLOW	INLET P-TOT	EXIT P-TOT	PTEX/ PTIN	EXIT P-STAT	PSEX/ PTIN
NOT PARAMETRIC → 12	4.78063E-02	23.450	16.840	0.71811	15.949	0.68015
13	4.78063E-02	23.450	16.840	0.71811	15.949	0.68015
14	4.78063E-02	23.450	15.780	0.67290	14.656	0.62500
15	3.78063E-02	23.450	19.768	0.84299	19.353	0.82528
16	3.78063E-02	23.450	19.323	0.82400	18.845	0.80364
17	4.78063E-02	23.450	16.672	0.71098	15.769	0.67244
18	4.78063E-02	23.450	15.581	0.66443	14.433	0.61549
19	3.78063E-02	23.450	19.692	0.83976	19.275	0.82196
20	3.78063E-02	23.450	19.243	0.82059	18.763	0.80012
21	4.78063E-02	28.450	23.615	0.83005	23.052	0.81025
22	4.78063E-02	28.450	23.015	0.80895	22.363	0.78606
23	3.78063E-02	28.450	25.573	0.89888	25.266	0.88807
24	3.78063E-02	28.450	25.251	0.88757	24.904	0.87537
25	4.78063E-02	28.450	23.519	0.82667	22.953	0.80677
26	4.78063E-02	28.450	22.912	0.80536	22.257	0.78233
27	3.78063E-02	28.450	25.518	0.89696	25.210	0.88612
28	3.78063E-02	28.450	25.195	0.88559	24.847	0.87336

SUMMARY PRINTOUT FOR 17 POINTS (GAS IS AIR , NO 1)
(CASES 12 THRU 28)

CASE	INLET T-TOT	EXIT T-TOT	TTEX/ TTIN	HEAT ADDITION	MAX AVE SURF-TEMP AT STGE
NOT PARAMETRIC → 12	91.0	500.0	1.74229	4.77145E 00	1237.9 10
13	91.0	500.0	1.74229	4.77145E 00	1237.9 10
14	91.0	600.0	1.92377	5.96513E 00	1517.4 10
15	91.0	500.0	1.74229	3.77337E 00	1198.1 10
16	91.0	600.0	1.92377	4.71736E 00	1467.1 10
17	191.0	500.0	1.47465	3.61882E 00	1037.0 10
18	191.0	600.0	1.62826	4.81250E 00	1313.6 10
19	191.0	500.0	1.47465	2.86184E 00	1009.1 10
20	191.0	600.0	1.62826	3.80583E 00	1275.7 10
21	91.0	500.0	1.74229	4.77145E 00	1237.9 10
22	91.0	600.0	1.92377	5.96513E 00	1517.4 10
23	91.0	500.0	1.74229	3.77337E 00	1198.1 10
24	91.0	600.0	1.92377	4.71736E 00	1467.1 10
25	191.0	500.0	1.47465	3.61882E 00	1037.0 10
26	191.0	600.0	1.62826	4.81250E 00	1313.6 10
27	191.0	500.0	1.47465	2.86184E 00	1009.1 10
28	191.0	600.0	1.62826	3.80583E 00	1275.7 10

1. There are slight discrepancies known to exist between the GFP binary program deck filed with GE FPLD Computations Operation and the Fortran source deck listed in the present report. Shortage of time has prevented reassembly of the offending subroutines. If such occurrences prove sufficiently inconvenient, it will be necessary for the user to reassemble these subroutines.

In the existing assembly of the INPPRT subroutine which prints out input data, parametric input is mislabeled. The order of labeling, left to right and first to second line, should be INLET TOT PRESS, INLET TEMP, EXIT TEMP, MAX AVE SURF TEMP, EXIT STAT PRESS, EXIT TOT PRESS, WEIGHT FLOW, and HEAT RELEASE. In addition, the geometrical cross section is mis-named in the heading of the processed geometry printout.

In the existing assembly of the OUTPUT subroutine which prints out the calculation results, the inlet Reynolds Number should be multiplied by 12 and what is listed as the exit Reynolds Number is actually the average Reynolds Number for the last stage. In addition, when feet are the basic unit of output, neither the stagewise heat transfer coefficients or mass velocities have their units changed.

As presently assembled, the DPFRLT subroutine which carries out the pressure drop computations can carry out only automatic interstage loss calculations or arbitrary interstage coefficient loss calculations, not an intermixture of the two types. This is an unreasonable situation and the source deck has been changed to permit such an intermixture.

The DATPRØ (data processing) subroutine will not distribute the modifying coefficients (CLSMØD) for automatic interstage loss coefficients by means of the mnemonic NCLSMØD. The source deck, however, has been corrected so that this distribution can be carried out if a reassembly is made.

2. Insofar as the writer knows, there are no requirements for the GFP program that cannot be carried out equally well by the IBM 704 and IBM 7090 computers. For other machines, this would presumably be dependent on the adequacy of the particular compiler which would have to operate upon the Fortran source deck. The TABLE specification which has been used many places in the GFP program may not be available for IBM 704 compilers, but standard coding methods can be used to accomplish the same purpose; it just takes more effort.
3. The LMPRØP subroutine discussed in Appendix A is rather annoying when used in an iterative program such as GFP. Although the final results of the calculations may lie well within the valid range for thermal property correlations, a monstrous number of comments could be printed out regarding the temperature limits of one or more properties because of extreme temperatures arising during the course of the iterations.

The writer recommends that serious consideration be given to the possibility of adding an extra control in COMMON storage which will actually control

outputting from LMPROP so that during iterations it will be suppressed but after convergence it will be functional. In general, this would require a repeat of the pressure drop and wall temperature calculation routines after it was established that convergence had taken place.

For the present, the writer has left (with some qualms a dummy version of LMPROP at the beginning of the binary deck on file. This version does not print comments. It may be wise to remove it for production usage.

4. It was mentioned in the Introduction that the GFP heat transfer treatment has been tailored to nuclear heat transfer problems. In such problems, it is usually known what amount of heat is going to be released and where the release will take place. Thus, the result to be obtained is usually the surface temperature which will result in convective transfer of the specified amount of heat into a coolant stream. For this reason, it has been possible to uncouple the heat transfer calculations from those for pressure drop.

Another type of problem for which it might be desirable to adapt the GFP program would be those where a desired axial surface temperature profile is known and it is desired to compute the resultant bulk fluid temperatures and convective heat transfer rates. Under these circumstances, a different (but more tightly bounded) type of iteration would be required in which the procedure might be as follows: (assuming the most difficult case of film-temperature-based heat transfer coefficient):

- a) Assume film temperature to be mean of inlet bulk and specified surface temperature for the stage and calculate convective heat transfer coefficient (CHTC).
- b) Calculate the enthalpy change in the fluid and its temperature change.
- c) Recompute the CHTC with the new film temperature and repeat steps b) and c) until bulk temperature change is less than some convergence criteria.

One matter that needs considerable thought in formulating such a routine is the question of whether one wants an average or mean temperature for the stage or a local temperature such as the trailing edge temperature. In the former case one would ordinarily base the film temperature drop on the mean temperature for the stage and modify the calculated enthalpy rise accordingly. In the latter case, it becomes somewhat tricky to compute the total enthalpy rise while at the same time getting the necessary local heat or enthalpy rate unless some sort of trailing edge factor can be established (similar to that used in the present version of GFP).

Obviously, it is not possible to uncouple the heat transfer and pressure drop computations in an example such as has been discussed wherein the heat transfer calculation determines the bulk temperatures which are needed in computing the pressure drop.

VIII NOMENCLATURE

VIII.1 Input Variables

<u>Math Symbol</u>	<u>Mnemonic</u>	<u>Col. 1 Control</u>	<u>Meaning or Function</u>
	FTIN	4	= 0 input is in inches and derivatives; > 0 input is in feet and derivatives;
	FTOUT	4	= 0 output is in inches and derivatives; > 0 output is in feet and derivatives;
	RNKIN	4	= 0 input is in deg. F > 0 input is in deg. R
	RNKOUT	4	= 0 output is in deg. F > 0 output is in deg. R
D _h	DH ₁₀₁	3	Hydraulic diams (offset)
A _{ff}	AFF ₁₀₁	3	Free flow area (offset)
	ROUND ₁₀₁	4	> 0 $AFF_1 = \frac{\pi}{4} DH_1^2$ automatically = 0 no action
L	LENGTH(ϕ LEN) ₁₀₁	3	Stage lengths (offset)
	CLLOSS ₁₀₁	3	Interstage loss coefficients (offset)
	NDH, NAFF(NAFL), NLEN, NCLLOSS }	4 100	Stagewise distribution controls for DH, AFF, LENGTH, and CLLOSS, respectively
P _{Tin}	PTIN(PIN)	3	Inlet total pressure
T _{Tin}	TTIN(TIN)	3	Inlet total temperature
P _{Tex}	PTEX(PEX)	3	Exit total pressure
P _{Sex}	PSEX	3	Exit static pressure
W	W	3	Mass flow
T _{Wmax}	TWMAX	3	Maximum stage trailing edge temperature
Q	QTOT	3	Passage heat release
T _{Tex}	TTEX(TEX)	3	Passage exit total temperature.
β_1 β_2	BETA1 BETA2 }	3	Entrance length effect friction factor coefficients for laminar and for turbulent flow, respectively.
a _L a _T	COFHLM COFHTB }	3	Nusselt No. coefficient for laminar and for turbulent flow, respectively.

VIII.1 Input Variables (continued)

b _L b _T	EXHPLM EXHPTB }	3	Prandtl No. exponent for laminar and for turbulent flow, respectively.
c _L c _T	EXHRLM EXHRTB }	3	Reynolds No. exponent for laminar and for turbulent flow, respectively.
d _L d _T	CØFFLM CØFFTB }	3	Friction factor coefficient for laminar and for turbulent flow, respectively.
e _L e _T	EXPFLM EXPFTB }	3	Reynolds no. exponent in friction factor correlation for laminar and for turbulent flow, respectively.
	ENTRNC	3	Calculate entrance length effects.
	GAS	3	Gas selector (1 for air, 4 for H ₂ , 6 for He, 9 for Ne)
	ACCMNØ	3	Fractional accuracy on Mach No. (initialized = 0.0001)
	ACCPRS	3	Fractional accuracy on pressures (initialized = 0.0001)
	ACCTMP	3	Absolute accuracy on temperatures (initialized = 0.049 deg.)
	LIMCHK	4	Number of consecutive time program can attempt to alleviate choking (if iterating for W) (initialized = 10)
	LMCHTØ	4	Total no. of terms choke alleviation can be attempted during a case (initialized = 30)
	LIMTRY	4	Maximum no. of times program can iterate for W. (initialized = 15)
	NØPRT	4	>0 print no input data nor output results except for summary table of 8 "major variables" (PTIN, TTIN, TTEX, PTEX, PSEX, TWMAX, W, QØT); = 0 no action.
	PARPRT	4	> 0 for each case, print no input data nor output results except for the 8 "Major variables"; = 0 no action.
	STAGES (* NØSTGE)	4	No. of stages (max of 100)
	PRTSUM	=	> 0 immediately print the full summary table of 8 "major" variables which otherwise prints only after 100 calculations (automatically reset= after use); = 0 no action.

VIII.1 Input Variables (continued)

	ALLRUN	4	> 0 always, if possible, carry out calculations for any record in which no error or omission was found regardless of what occurred during previous records; = 0 carry out no calculations once an error or omission has been found but merely search remaining records for DIP-type errors.
	T ϕ TLEN	3	Total length of passage, to be used with stage lengths specified by XOL (X/L)
	X ϕ L ₁₀₀	3	Fraction of total length to current stage exit.
	CASE(KASE)	4	Case number (initialized = 1)
	CASTEP(KASTEP)	4	Interval between case numbers for automatic case numbering (initialized = 1)
ϕ_B	PHISUM ₁₀₀	3	Fraction of total power released by end of current stage.
ϕ_X	PHIEX ₁₀₀	3	Stage exit to stage average power
	P0,P1,P2 ₁₀₀	3	Tabular power profile; stage entrance, midpoint, and exit tables, respectively.
	PTX ϕ PI	3	PTEX/PTIN, an alternate way of specifying PTEX
	PSX ϕ PI	3	PSEX/PTIN, an alternate way of specifying PSEX.
	TEX ϕ TI	3	TTEX/TTIN (ratio based on absolute temperature), an alternate way of specifying TTEX. (<u>Not</u> necessary to load TTIN in deg. R)
	N ϕ PTIN	4	No. of parametric entries for PTIN
	N ϕ TTIN	4	(zero and one treated as equivalent)
	N ϕ TWMX	4	(** KPARAM)
	N ϕ QT ϕ T	4	PTIN
	N ϕ PSEX	4	TTIN
	N ϕ PTEX	4	TWMX
	N ϕ W	4	QT ϕ T
	N ϕ TTEX	4	PSEX
			PTEX
			W
			TTEX
	DPTIN	3	Increment for parametric steps for (units as loaded)
	DTTIN	3	(** DPARAM)
	DTWMX	3	PTIN
	DQT ϕ T	3	TTIN
	DPSEX	3	TWMX
	DPTEX	3	QT ϕ T
	DW	3	PSEX
	DTTEX	3	PTEX
			W
			TTEX

VIII.1 Input Variables (continued)

	AUTOCLS	3	> 0 calculate automatic interstage loss coefficient if area change encountered.
	CLSMOD ₁₀₁ (CLSMDI ₁₀₀)	3	Multiplier for automatically generated interstage loss coefficient. (initialized = 1)
	NCLSMOD ₁₀₀	4	Distribution variable for CLSMOD
L _w	WIDTH ₁₀₁ (DHD)	3	Width and height of rectangular passage from which D _h and A _{ff} are to be automatically calculated.
L _h	HEIGHT ₁₀₁ (AFFD)	3	
D _{maj}	ELPMAS ₁₀₁ (DHD)	3	Major and minor axes of an elliptical passage from which D _h and A _{ff} are to be calculated.
D _{min}	ELPMIN ₁₀₁ (AFFD)	3	
D _{outer}	DOUTER ₁₀₁ (DHD)	3	Outer and inner effective diameter of concentric ring assembly (half-rings at inner and outer surface.)
D _{inner}	DINNER ₁₀₁ (AFFD)	3	
tring	THICK ₁₀₁	3	Thickness of individual ring in concentric ring assembly.
n	NORING ₁₀₁	4	No. of rings in concentric ring assembly, including inner and outer half rings.
	RECTNG	4	> 0 cross section is rectangular.
	ELLIPS	4	> 0 cross section is elliptical
	RINGS	4	> 0 cross section is concentric ring assembly.
	HMULT ₁₀₁	3	Stagewise multiplier on calculated heat transfer coefficients (all initialized = 1)
	NHMULT ₁₀₀	4	Distribution control for HMULT
	FMULT ₁₀₁	3	Stagewise multiplier on calculated friction factors (all initialized = 1)
	NFMULT ₁₀₀	4	Distribution control for FMULT
	HEADER (HEDDUM ₁₂)	B	Heading comment
	CIN,CEX	3	Entrance and exit loss coefficients
	LIMPRS	4	Counter limit on pressure and wall temperature iterations for one stage. (initialized = 20)

VIII.1 Input Variables (continued)

PRTALL	4	Print complete stage output including dynamic pressures, static pressures, heat transfer coeff, friction factors, and automatically generated interstage loss coefficients, if any.
MAXMNO (QMAXD)	3	Starting value for max passageMach No. to match in choking remedial (where possible) (initialized = .5)
NQINPT	4	Suppress all input printout.
MAXTMP	4	Stage at which TWMAX is to be obtained when iterating to match TWMAX. Zero means hottest stage is used.
LMBULK	4	> 0 use bulk temperature for laminar heat transfer correlation.
TBBULK	4	> 0 use bulk temperature for turbulent heat transfer correlation
TRANSF	3	Transition N_{Re} for friction factor (initialized = 2300)
TRANHL	3	Lower bound for N_{Nu} transition region (initialized = 2000)
TRANHU	3	Upper bound for N_{Nu} transition region (initialized = 8000)
NEWSET	4	> 0 replace BSI table by BSO. Enables retrieval of newly calculated quantities to be used as subsequent design constraints during a given machine run. In the event that the case fails, will result in program exiting regardless of ALLRUN will also fill QBAR.
QBAR	3	Reference heat release level. (Can be internally filled by QOQBAR) (BUT/sec)
QOQBAR	3	QTOT/QBAR. Will override a QTOT input value.
NQGEOM	4	> 0 do not print geometrical and power profile input.

VIII.2 Internal Variables

<u>Math Symbol</u>	<u>Mnemonic</u>	<u>Purpose</u>
	KTRCRD	DIP record counter
	KALCNØ	Sequential number of successful calculation
	DEAD	> 0 means some kind of error found. Causes searching of DIP records for DIP errors unless ALLRUN > 0. If = 0, no action.
	KTCHAD	Counts choke adjustments for a single wt. flow.
	KTWADJ	Counts wt. flow adjustments
	KTCHTØ	Counts total choke adjustments for a case.
	BSI ₁₁	Grouping variable for 8 major input variables + 3 ratios.
	BSØ ₁₁	Grouping variable for 8 major output variables + 3 ratios.
	DHD ₁₀₀	Input hydraulic diams. with offset removed.
	DHI ₁₀₀	Calculation table of hydraulic diams.
	AFFD ₁₀₀	Input free flow areas with offset removed.
	AFFI ₁₀₀	Calculation table of free flow areas.
	ØLEND ₁₀₀	Input stage lengths with offset removed.
	ØLENI ₁₀₀	Calculation table of stage lengths.
	TØTLND	Calculation total passage length.
	XØLD ₁₀₀	Calculation table of X/L stations
	CLØSSD ₁₀₀	Input interstage loss table with offset removed.
	CLØSSI ₁₀₀	Calculation table of interstage loss coefficients.
	PIND	Calculation value of PTIN
	TIND	Calculation value of TTIN
	TWMAXD	Calculation value of TWMAX
	TEXTD	Calculation value of TTEX
	QTØTD	Calculation value of QTØT

VIII.2 Internal Variables (continued)

	PEXD	Calculation value of PTEX
	PSEXD	Calculation value of PSEX
	WD	Calculation value of W
	GRTMPI ₃	Grouping variable for temperature input
	GRTMP ₃	Grouping variable for temperature calculations
	FTABI ₄	Grouping variable for friction factor data
	HTABI ₅	Grouping variable for heat transfer data
	NSKPPR	> 0 skip pressure drop calculations = 0 no action.
	NSKPHT	> 0 skip heat transfer calculation = 0 no action
	ENTRN	Calculation entrance length effect signal.
	K _{POW}	> 0 Power profile loaded. = 0 no power profile loaded
	K _{OPT}	Carries calculation option number, if any
	K _{OSCIL}	Counter to detect if iteration is "oscillating" and tighter tolerances might be required on press drop and Mach No.
	SVACMN	Saves original Mach No. accuracy
	SVACPR	Saves original press drop accuracy
	ITRY	Independent variable iteration counter.
	TRYO,1,2,3	Iteration values of independent variables
	GOAL	The quantity which the iteration is trying to satisfy.
H _{in}	HIN	Inlet enthalpy
H	DELH	Total enthalpy release
G	GMASS ₁₀₀	Mass velocities
T _{exi} or T _b	TEXI ₁₀₀	Stage exit bulk temperatures
	KCH _{KE}	Choke signal; if > 0, gives stage where choke occurred.

VIII.2 Internal Variables (continued)

YIELD0,1,2	Current value of quantity being iterated for	
TEST1	A difference used in determining whether convergence achieved.	
NT,LØC	Used for error identification.	
DERIV	The "straight-line" derivative	
AD,BD,FD	Coefficients in 3-point fit.	
MØRCAS	>0 means more cases to be parametrically generated without reading in anymore data; = 0 read in more data.	
KPARMR(M) M=1	Internal parametric counters for	PTIN
2	(always initialized one less	TTIN
3	than input value)	TWMAX
4		QTØT
5	(KPARMR ₈)	PSEX
6		PTEX
7		W
8		TTEX
KPARAM ₈	Grouping variable for input parametric counters. (used for resets)	
FPARAM ₈	Grouping variable for starting values of the 8 major flow variables (used only in parametric studies).	
DPARAM ₈	Grouping variable for input parametric increments.	
DPARMI(M) M=1	Grouping variable for internal parametric	PTIN
2	increments with needed unit changes.	TTIN
3		TWMAX
4		QTØT
5		PSEX
6		PTEX
7		W
8		TTEX
FSTPAR	>0 signals that first parametric case is being carried out; = 0 not first case.	
NTWMAX } NØTWMA }	Variations of NØTWMX	
KPARMR ₈	Running counters for parametric studies.	

VIII.2 Internal Variables (continued)

	PIN TIN PEX TEX	Variations of PTIN, TTIN, PTEX, TTEX
	KONOPT _{2,10}	Table to enable convenient retrieval of variables associated with iterations to satisfy option (preset)
	KONPAR _{4,13}	Table (preset) which retrieves appropriate counters during parametric studies.
	KSHIFT ₇₂ KUP ₇₂	Grouping variables used in lower and COMMON memory, respectively, for transfer fill of KONOPT and KONPAR
C _L	CLSGEN ₁₀₀	Automatically generated interstage loss coefficients.
	PSPID(BSØ(9))	PSEXID/PIND
	PTPID(BSØ(10))	PEXD/PIND
	TXPID(BSØ(11))	TEXD/TIND
	SAVTAB _{13,100}	Grouped summary table. 2 thru 11 correspond to BSØ(1-11). SAVTAB(1) used for case number. SAVTAB(13) = NHØT
	NHØT	Stage no. where TWMAXD located
	KRSCØN ₄	Cross section control group (in priority sequence)
	KRT	A logical routing variable
	ND	A dummy subscript
	K1,K2,K3	Backspacing controls for cross-section processing
	AFFLØC THKLØC NRGLØC	Dummy variables used in backspacing logic
	FRINGS	Floating point version of local no. of rings.
	NRINGD ₁₀₀	Internal (offset) version of NØRING
	THICKD ₁₀₀	Internal (offset) version of THICK
	BWHEN ₂	Units; input or output (H)
	BUNLEN _{4,2}	Units; inch or foot (H)

VIII.2 Internal Variables (continued)

	BUNTMP ₂	Units; F or R (H)
	HEDDUM ₁₂	Table for heading comment
T _w	TW ₁₀₀	Trailing edge surface temperatures
M _{ex}	OMEXI ₁₀₀	Stage exit Mach Nos.
N _{Re}	REYNØ ₁₀₀	Stage average Reynolds No.
h	CØNVEC ₁₀₀	Heat transfer coefficients
f	FRIC ₁₀₀	Friction factors
	DPINT ₁₀₀	Interstage pressure losses
	KFIRST	Dummy variable used in MAIN to check SR ERROR returns.
	DUMDIP	Used in SR READIN to skip first DIP list
	ØMAXD	Internal mnemonic for MAXMNO
	ØMAX	Maximum passage Mach No.
	ØMAXL	Current criteria for maximum Mach No.
	KØPTH	< 0 means KØPT > 10.
	WHI	Lowest choking mass flow or highest non-choking inlet pressure
	WLØ	Highest non-choking mass flow or highest choking inlet pressure.
	DMCØNV	Dummy convergence criteria used for iterations (may be ACCPRS or ACCTMP)
	KDI	Subscript which retrieves independent variable from BSO
	KDD	Subscript which retrieves dependent variable from BSO
	KD1, KD2, KD3, etc.	Dummy subscripts.
	PRTCRS _{2,5}	Table with mnemonics to identify cross section
	CRSHD1, CRSHD2 _{8,4}	Format inserts for cross section printout format.
	TRYMAX	High value of best bound for independent variable.

VIII.2 Internal Variables (continued)

	PDYIN	Inlet dynamic pressure, after entrance loss
	PDYEX	Exit dynamic pressure, before exit loss
	ϕ MINLT	Entrance Mach No. after entrance loss
	ϕ MEXIT	Exit Mach No. before exit loss
	REYNIN	Entrance Reynolds No., after entrance loss
	DPIN	Entrance loss, tot press.
	DPEX	Exit loss, tot press.
P _{sexi}	PSEXI ₁₀₀	Stage exit static pressures
P _{dyn}	PDYEXI ₁₀₀	Stage exit dynamic pressures
	TRYMIN	Low value of best bound for independent variable
	TESTP	Smallest difference between GOAL and yield; yield < GOAL.
	TRYP	Value of independent variable associated with TESTP; used as a bound.
	TESTM	Smallest difference between GOAL and yield; yield > GOAL.
	TRYM	Value of independent variable associated with TESTM; used as a bound.
	T1	Dummy used as old value of independent variable in testing for increment to new value.
	T2	Dummy used for new value of independent variable in testing for increment to new value and testing whether new value lies between bounds.
	TSTGRP ₄	Groups TRYP, TESTP, TRYM, and TESTM
	KT ϕ TPR	Total no. of cases to be generated in parametric study.
	KTPAR	Counter on no. of parametric case tried.
	KASESV	Used to save original case number when performing parametric studies.
X	SUMLEN	Distance from beginning of passage to end of current stage
M _{1n}	ϕ MINI	Entrance Mach No. for current stage.

VIII.2 Internal Variables (continued)

P_{ini}	PINI	Entrance total pressure for current stage
$T_H()$	TMPEM(-1 mode)	Temperature as a function of enthalpy
$H_T()$	TMPEM(1 mode)	Enthalpy as a function of temperature
T_{ini}	TINI	Inlet total temp. to current stage
γ	GAM()	A function for C_p/C_v
g		Conversion factor 32.17
R	R()	A function for the gas constant
T_f	TAVG	Film temp, in SR TWLT. Otherwise, stage average bulk temperature.
μ	VISC()	A function to calculate absolute viscosity
k	TC()	A function to calculate thermal conductivity
η	ETA	Curve-fitting parameter in transitional heat flow.
N_{Re1}	TRANHU	Upper Reynolds No. limit for transitional heat flow.
N_{Re0}	TRANHL	Lower Reynolds No. limit for transitional heat flow.
H_{calc}	ENTRY	A calculated value of stage enthalpy release during surface temperature "iterations".
ψ	PSI	An intermediate variable used in SR LOSS
N_{Nu}	STGNNU	Stage Nusselt No.
N_{Pr}	STGPRN	Stage Prandtl No.

VIII.3 Miscellaneous Notation

<u>Math Symbol</u>	<u>Definition</u>
P_T	A total pressure
T_T	A total temperature
W_{est}	A value of mass flow as independent variable
$P_{ex-calc}$	An exit pressure, static or total, calculated during iterations
$P_{tin-est}$	A value of inlet total press. as independent variable
A	A flow area
f_{∞}	A fully developed friction factor
$N_{Nu_{\infty}}$	A fully developed Nusselt No.

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2. Delaney, J. A., Dyer, P. A., and Skirvin, S. C., "Off-Design and Modified Off-Design Programs", GE ANPD, DC 60-7-12, 6/60. (U)
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4. Kayes, W. M., and Clark, S. H., "A Summary of Basic Heat Transfer and Flow Friction Data for Plain Plate-Fin Heat Exchanger Surfaces", Tech. Rept. #17, 8/15/53, Dept. Mech. Engrg., Stanford University, Stanford, California.
5. McAdams, W. H., "Heat Transmission", New York, 1954 (3rd edition). p. 159
6. Shapiro, A. H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronald, New York, 1953. Chapter 8.
7. Wegstein, J. H., "Accelerating Convergence of Iterative Processes", Comm. A. C. M., Vol. 1, January 1959, p. 5.

Table 1 - Subroutines Coded Especially for GFP

<u>NAME</u>	<u>PURPOSE</u>	<u>CARD</u>
MAIN	Controls calling of major subroutines.	0002 - 0097
C O NSIS	Checks adequacy and consistency of data. Also selects calculation option.	0099 - 0347
DATPR O	Handles transfers and distribution from input tables to calculation tables. Also handles unit changes.	0349 - 0658
DPFRLT	Pressure drop calculation.	0660 - 0913
INITAL	Performs all pre-load initialization.	0970 - 1137
INPPRT	Handles printout of input data.	1140 - 1523
ITRC O N	Handles the entire execution of the calculation option.	1525 - 1939
OUTPUT	Prints normal output.	1941 - 2280
READIN	Contains DIP-list and DIP error checker. Has optional feature which allows program to run from future records if sufficient data are present.	2282 - 2539
RESET	Erases most of calculation data fields in preparation for a change case.	2541 - 2661
SETYLD(I,A)	Selects the current value of the iteration yield from DPFRLT output. (Zero arg I extracts all possible yield variables)	2663 - 2730
SUMPRT	Prints data summary (up to 100 runs)	2732 - 2929
TWLT	Wall temperature calculation.	2931 - 3292
UNCHOKE	Adjusts mass flow in event of choke if option permits.	3294 - 3509

Table 1. Non-departmental Utility Subroutines

<u>NAME</u>	<u>PURPOSE</u>	<u>CARDS</u>
GAM	Computes c_p/c_v (γ) as function of temperature	3511 - 3560
LMPR/P	Prints comment when temp limit of property exceeded.	3562 - 3585
NPR/P	Prints comment when property not available for a specific gas.	3587 - 3605
PRN	Computes Prandtl No. (N_{Pr}) as function of temp.	3606 - 3655
R	Yields gas constant for selected gases.	3657 - 3688
TC	Computes thermal conductivity (k) as function of temp. (BTU/sec-in-°R)	3691 - 3742
TEMPENT	Function yielding temperature or enthalpy.	3744 - 3862
VISC	Computes viscosity (μ) as function of temp (lbm/ft-sec)	3864 - 3908
AMACH	Computes Mach No. from total properties	3910 - 3928
C/TEMP	Converts Fahrenheit temps to Rankine or vice versa	3930 - 3957
ISTRBL	Used to distribute data in tables.	3959 - 4012
DYPER	Computes dynamic pressure from total properties	4014 - 4024
EXTRAP	Performs linear (with 2 pts.) and quadratic (with 3 pts.) extrapolations.	4026 - 4062
FLWFUN	Computes mass flow from total properties	4064 - 4072
PPRNT	(checkout print of floating point data.	4074 - 4082
L/SS	Computes incompressible sudden expansion and contraction losses.	4084 - 4124
NETERR	Prints error codes.	4126 - 4139
PW/ERR	Uses Simpson's rule to integrate tabular power profiles	4141 - 4167
PRSFUN	Computes total pressure from flow and remaining total properties.	4169 - 4176
PSAT	Computes static pressure from total properties.	4178 - 4185
SEINSP	Inspects first card of input data record.	4187 - 4211
XPRNT	Checkout print of fixed point data.	4213 - 4221

Figure 1 - Logical Flow Chart of the GFP Main Program

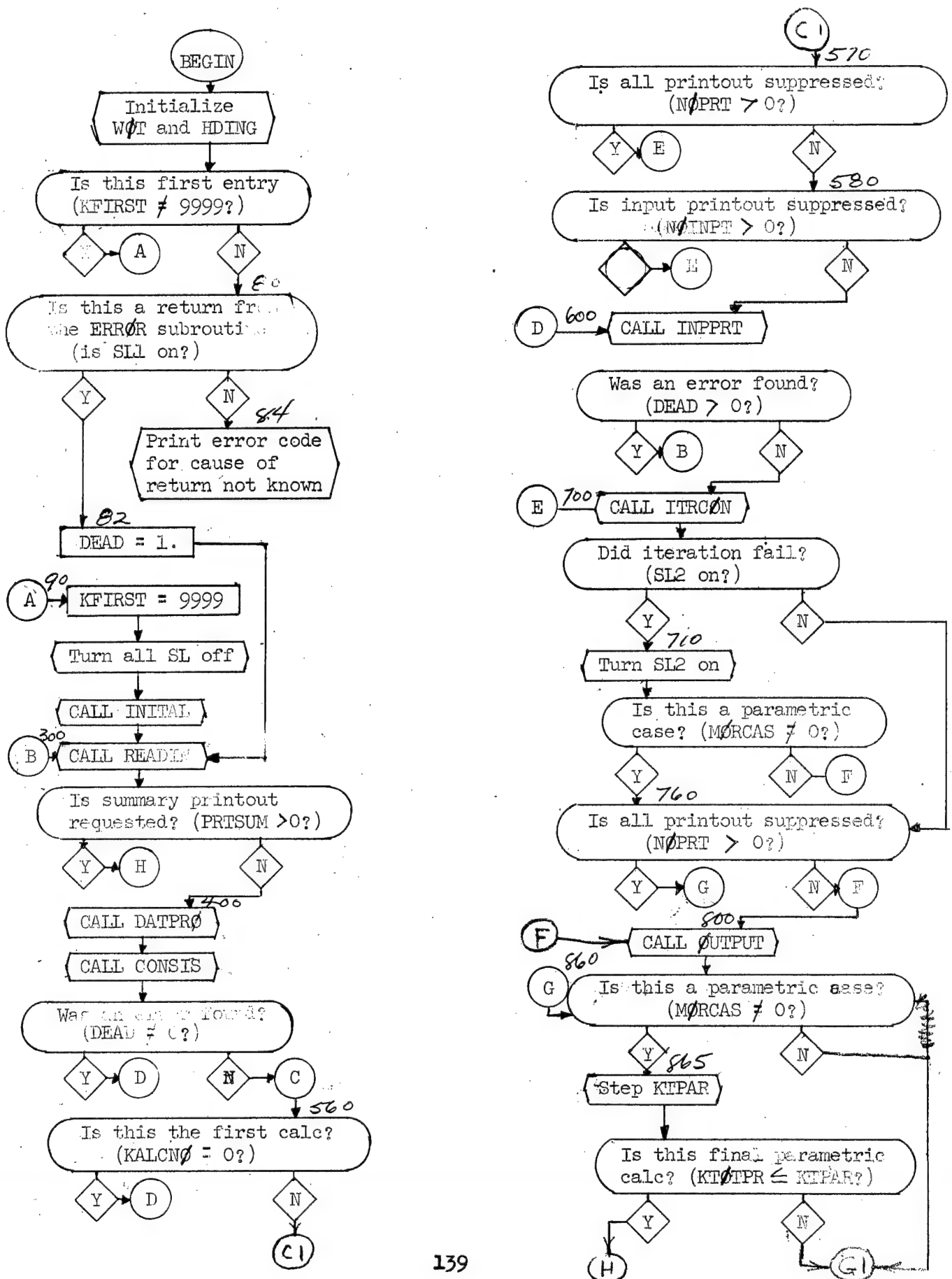


Figure 1 (continued)

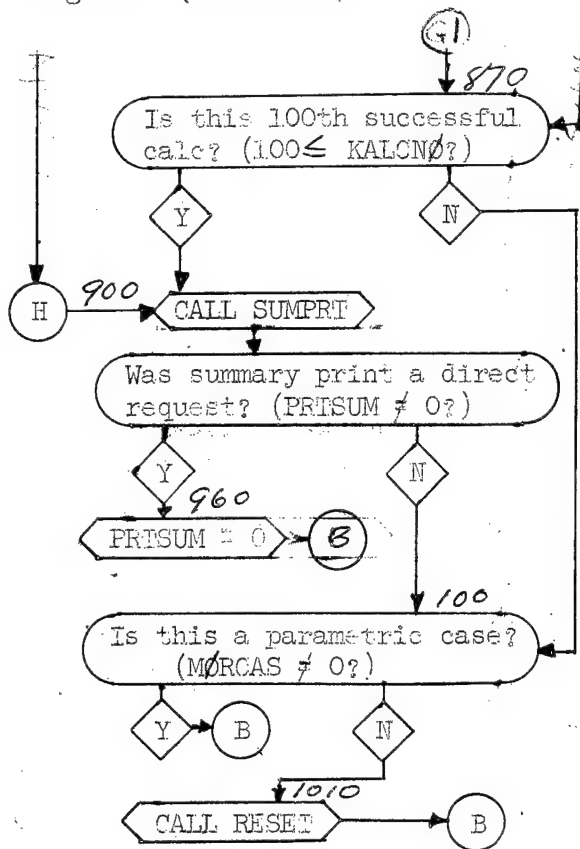


Figure 2 - Logical Flow Chart of the Iteration Control Subroutine (ITERCON) for the General Flow Passage Program

NOTE: KDD and KDI retrieve the dependent and independent variable, respectively, from the BS~~0~~ table.

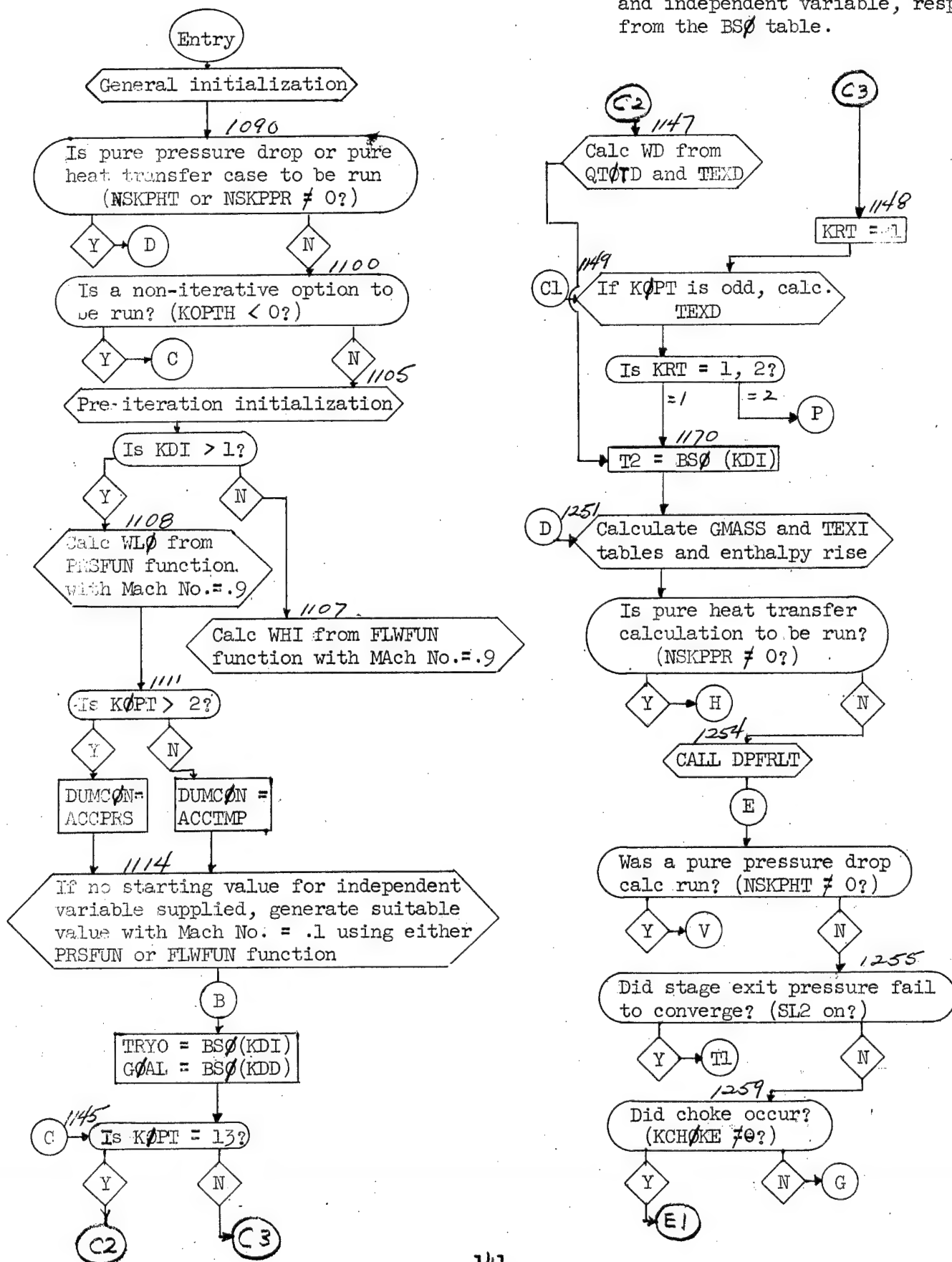


Figure 2 (continued)

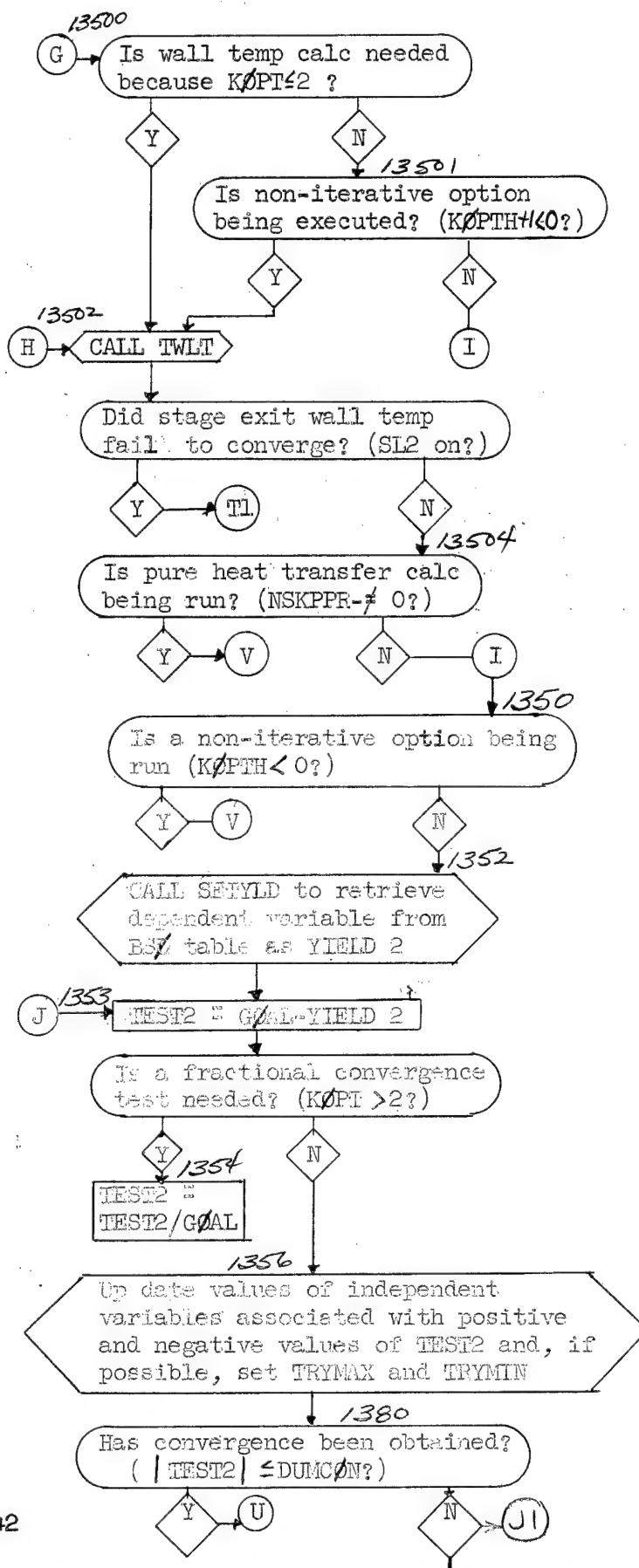
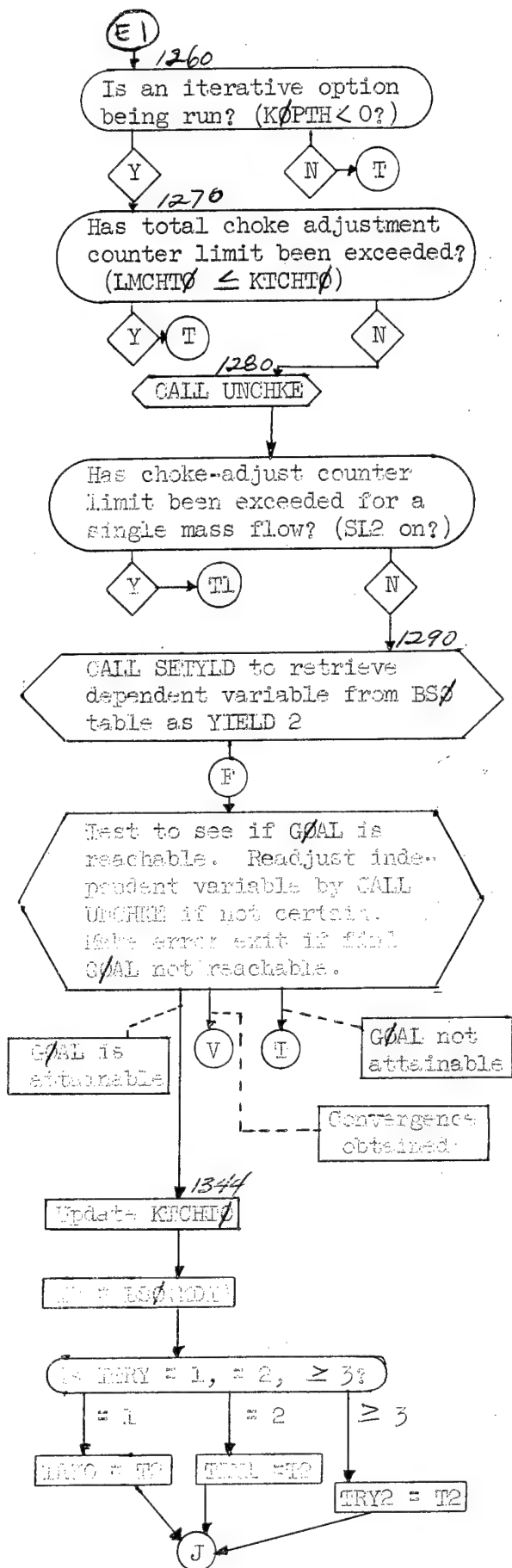


Figure 2 (continued)

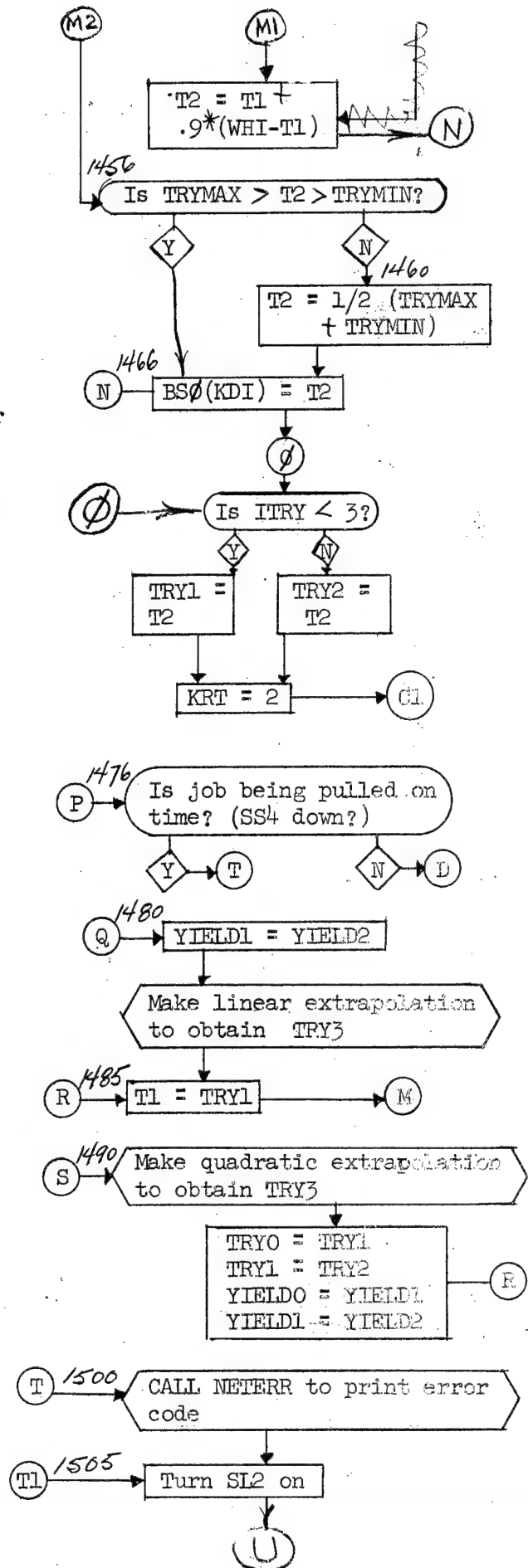
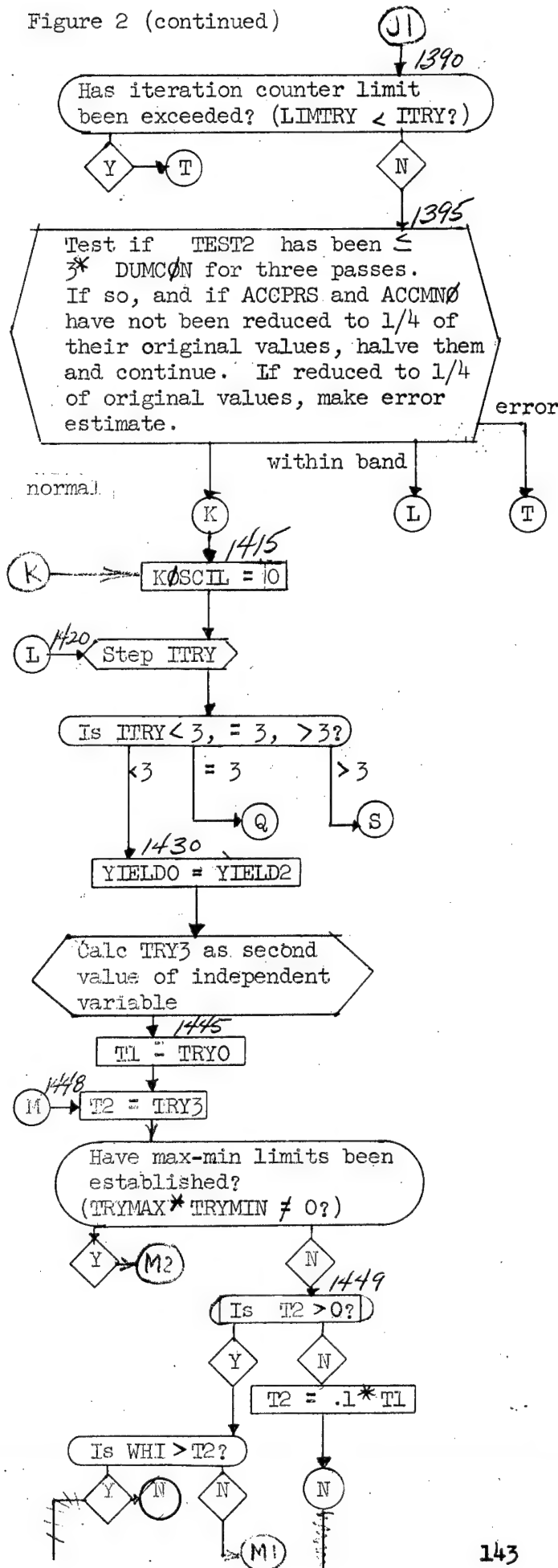


Fig. 2 (continued)

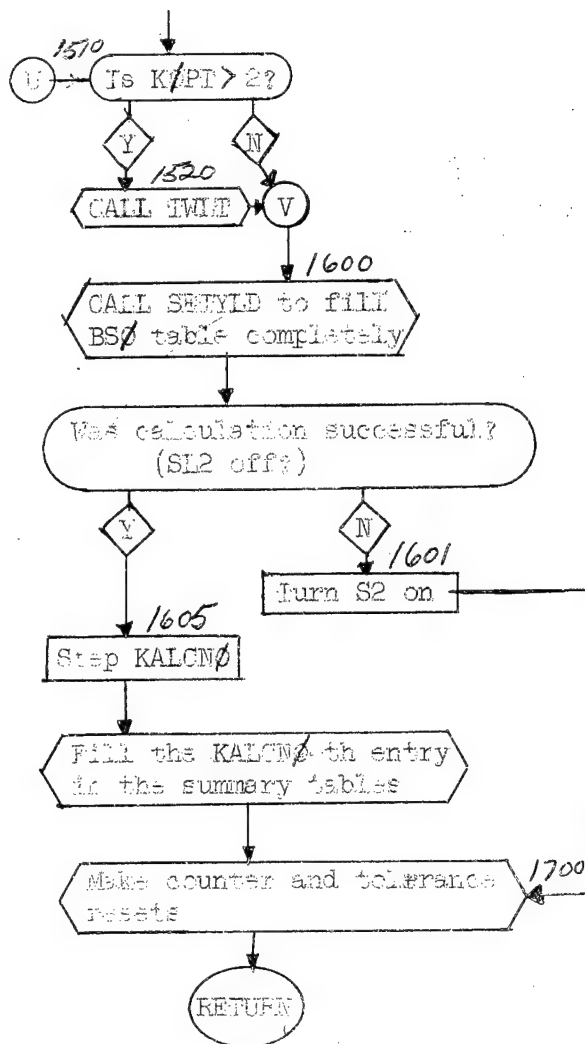
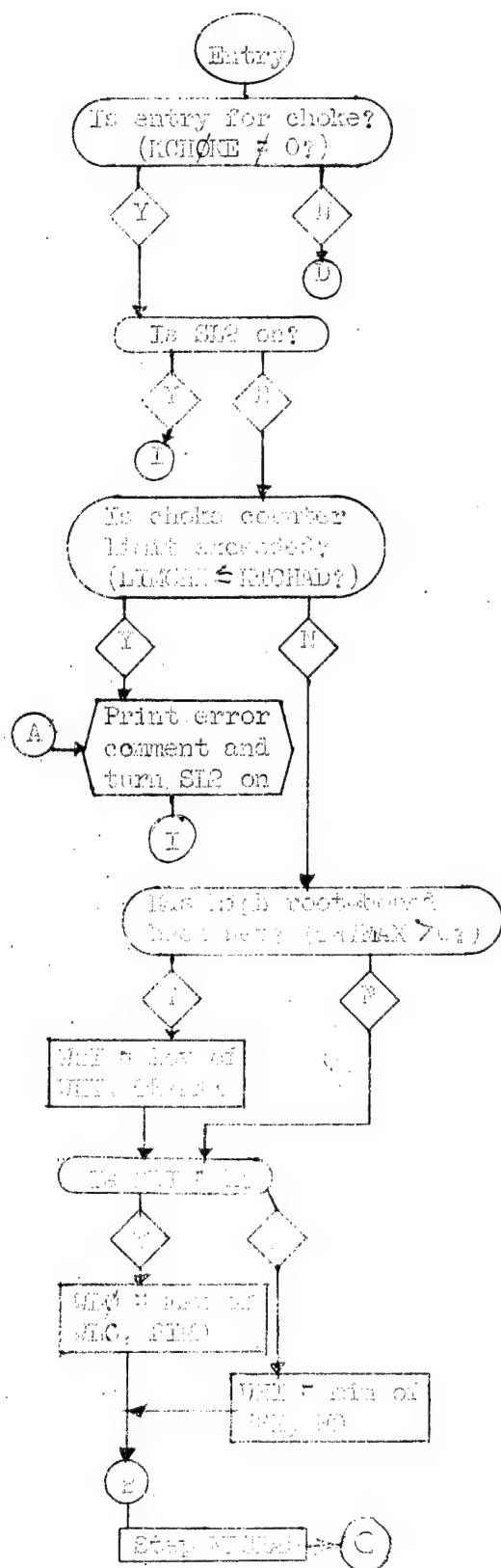


Figure 3 - Logical Flow Chart of the UNCHKE Subroutine for the General Flow Passage Program



NOTE: If KDI = 7, mass flow is the independent variable. If KDI = 1, inlet total pressure is the independent variable. ~~NOCHKE~~ is set to stage where choke occurred. ~~BSO~~(KDI) is the independent variable

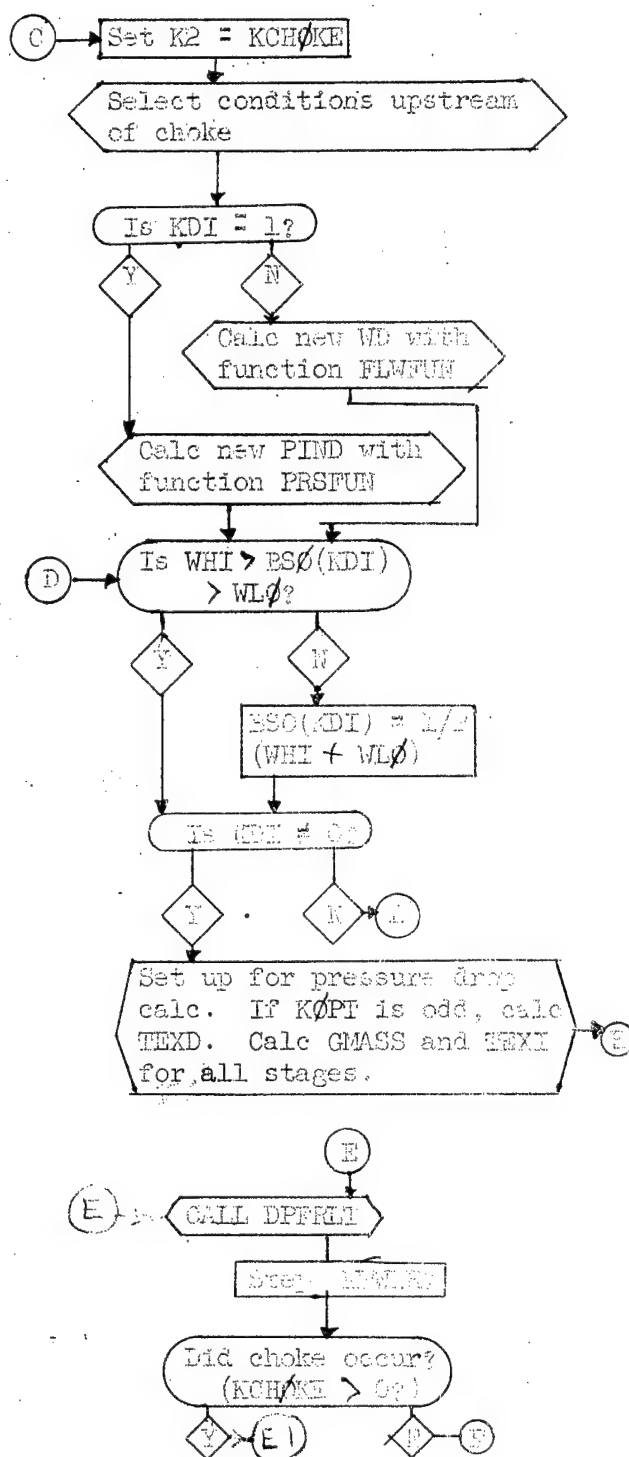


Figure 3 (continued)

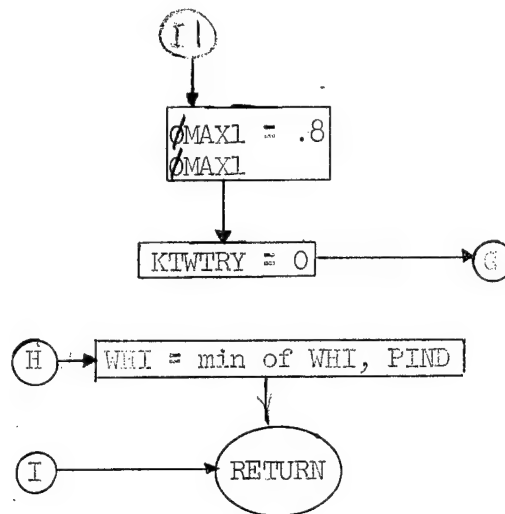
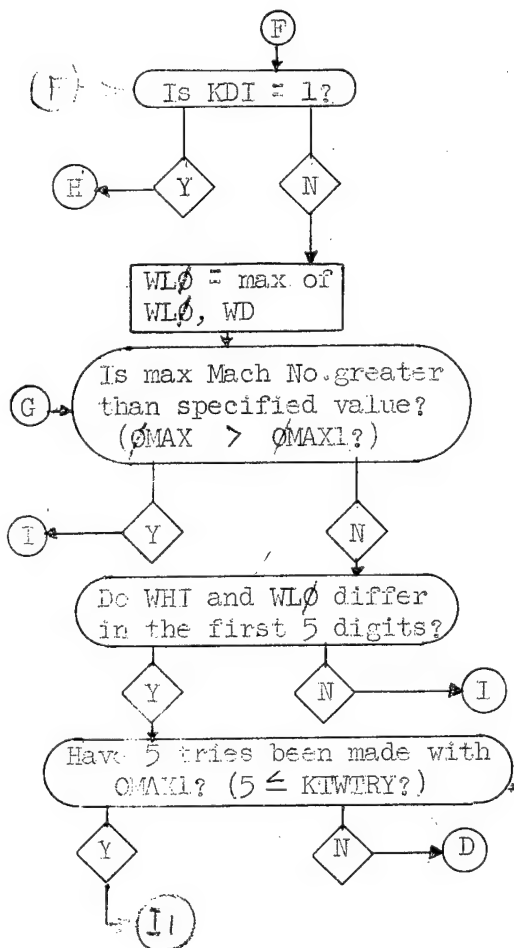
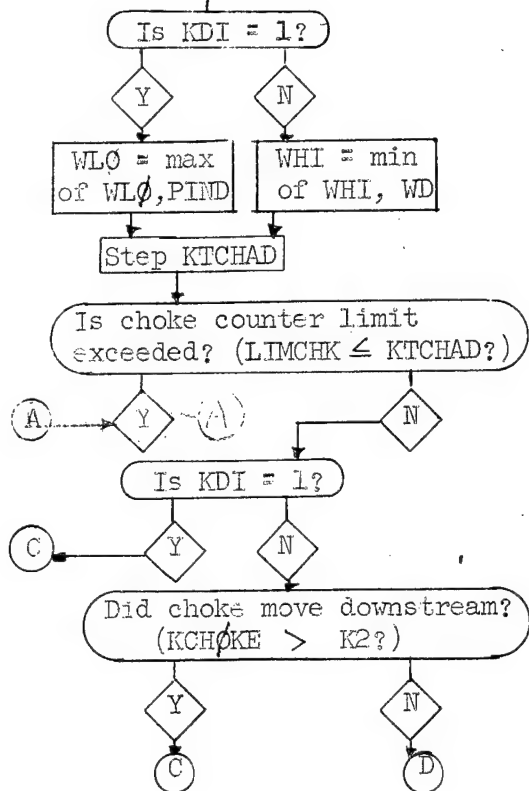


Figure 4 - Logical Flow Chart of the Surface Temperature Calculations (in Subroutine TWLF) for the General Flow Passage Program

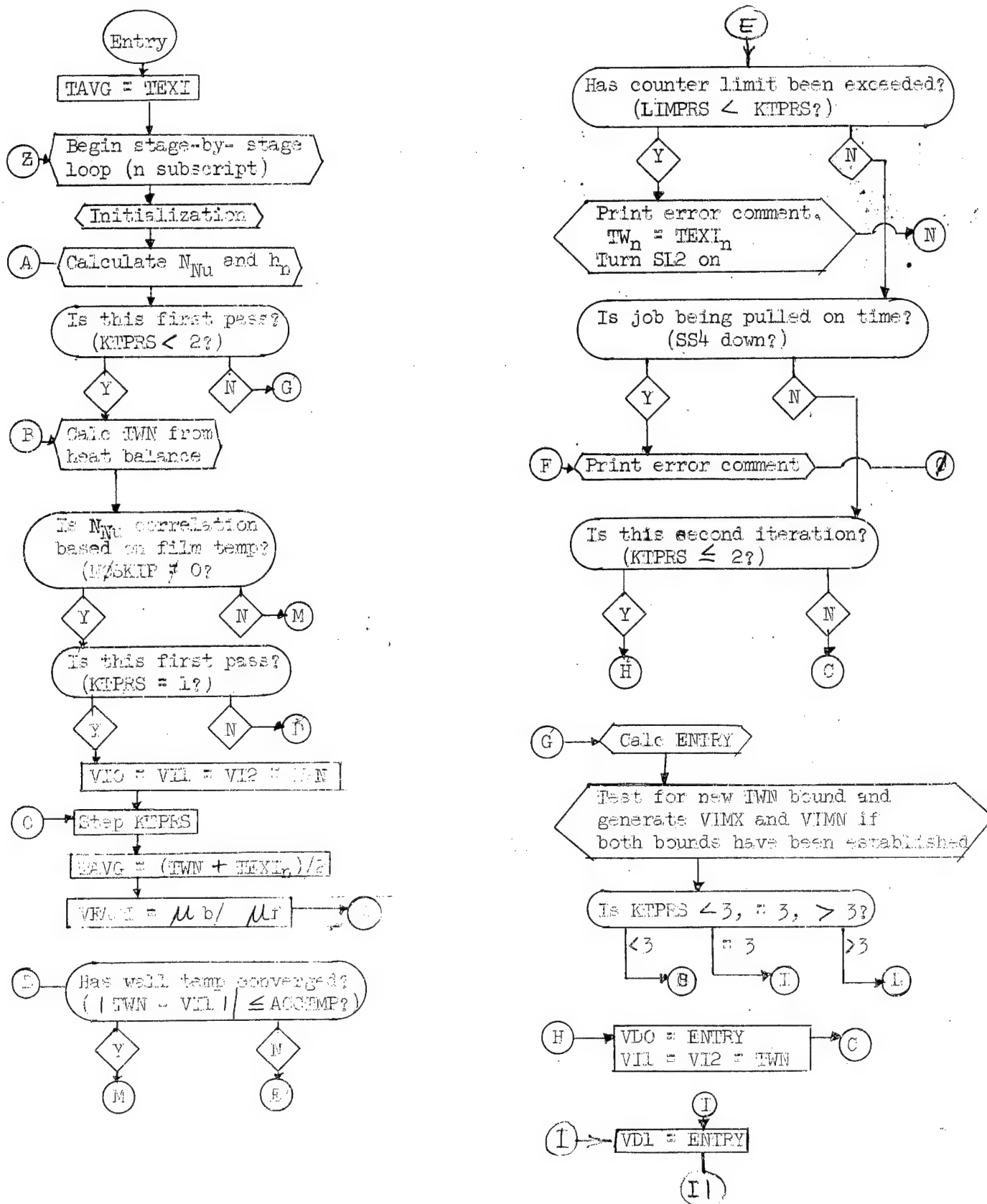


Figure 4 (continued)

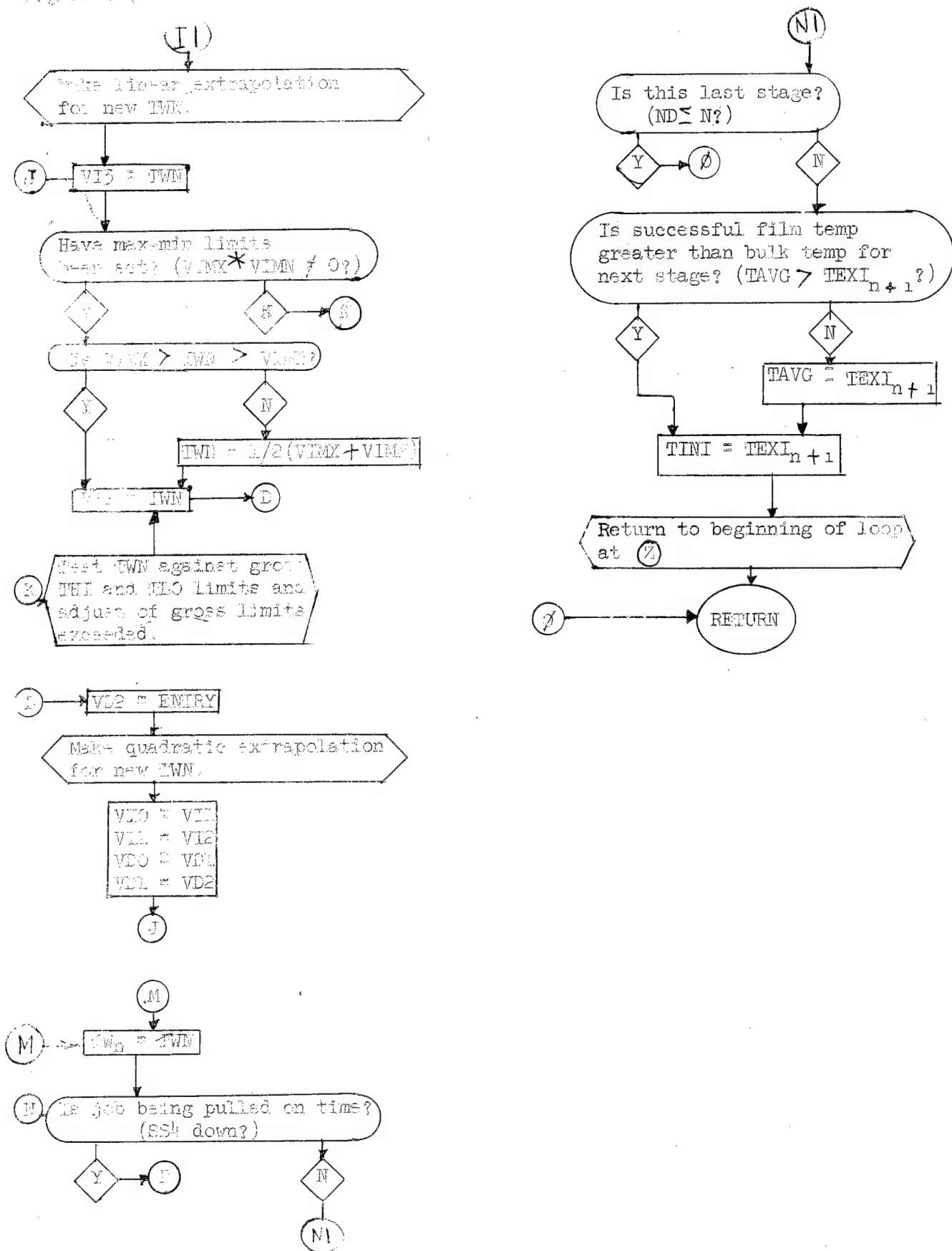
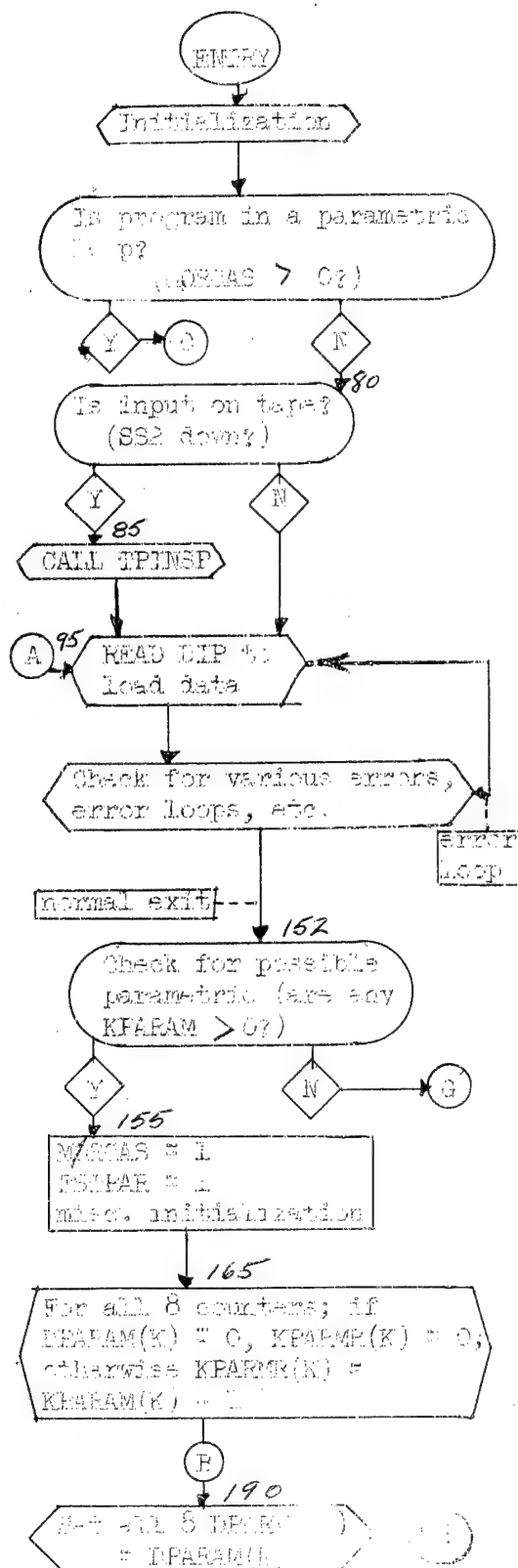


Figure 5 - Major Parameter Control Logical Flow Chart for the GFP Program
(in Subroutine MAIN)



NOTE: The KCONPAR table has 4 subscripts for each KOPT, which retrieve the proper counters from the KFARM table.

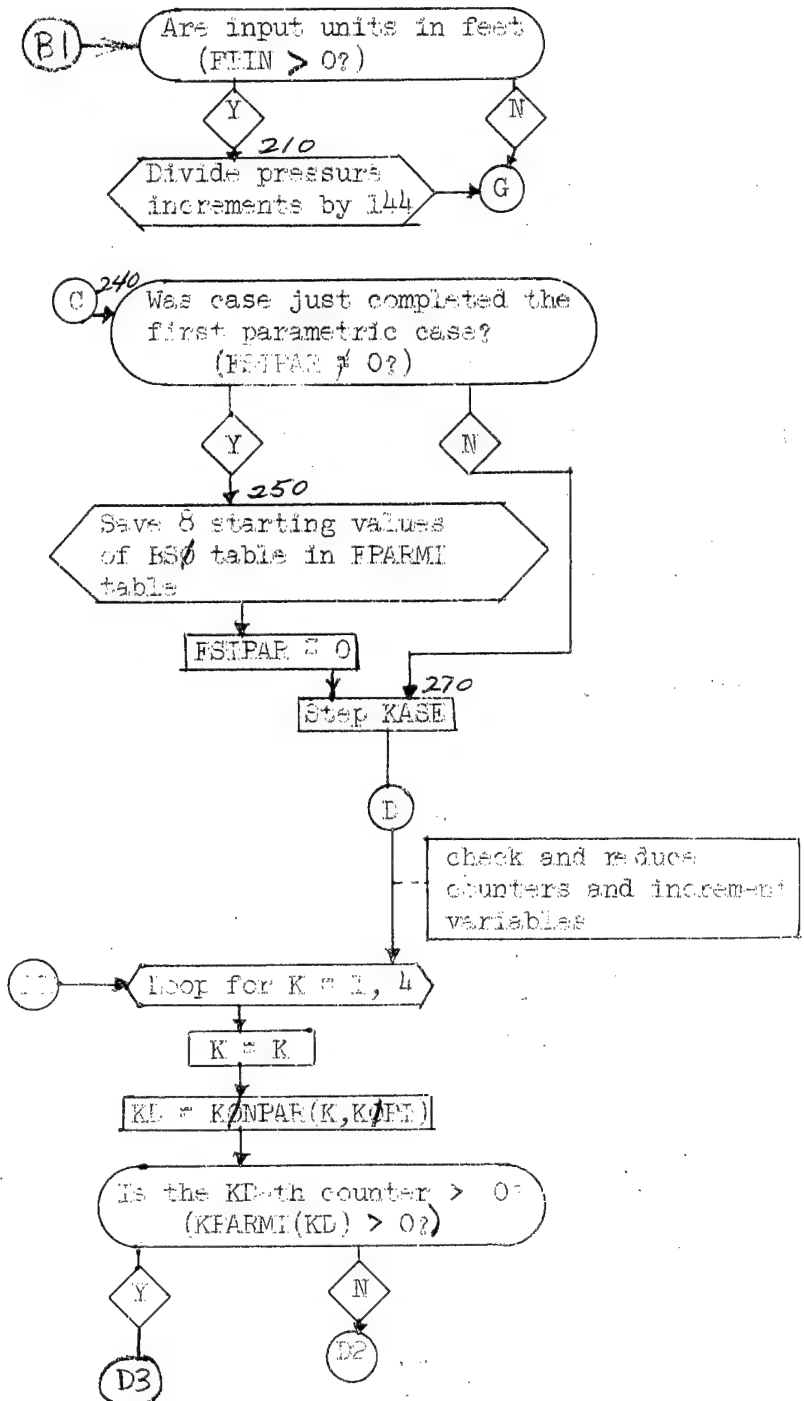
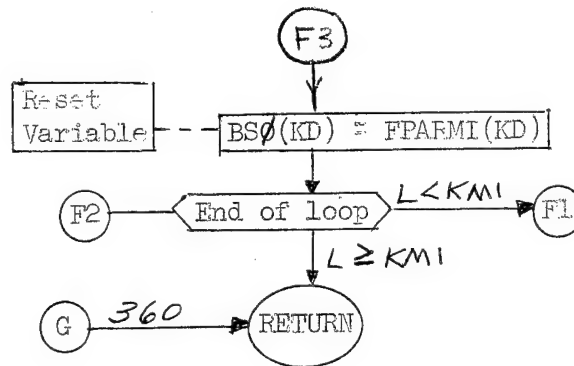
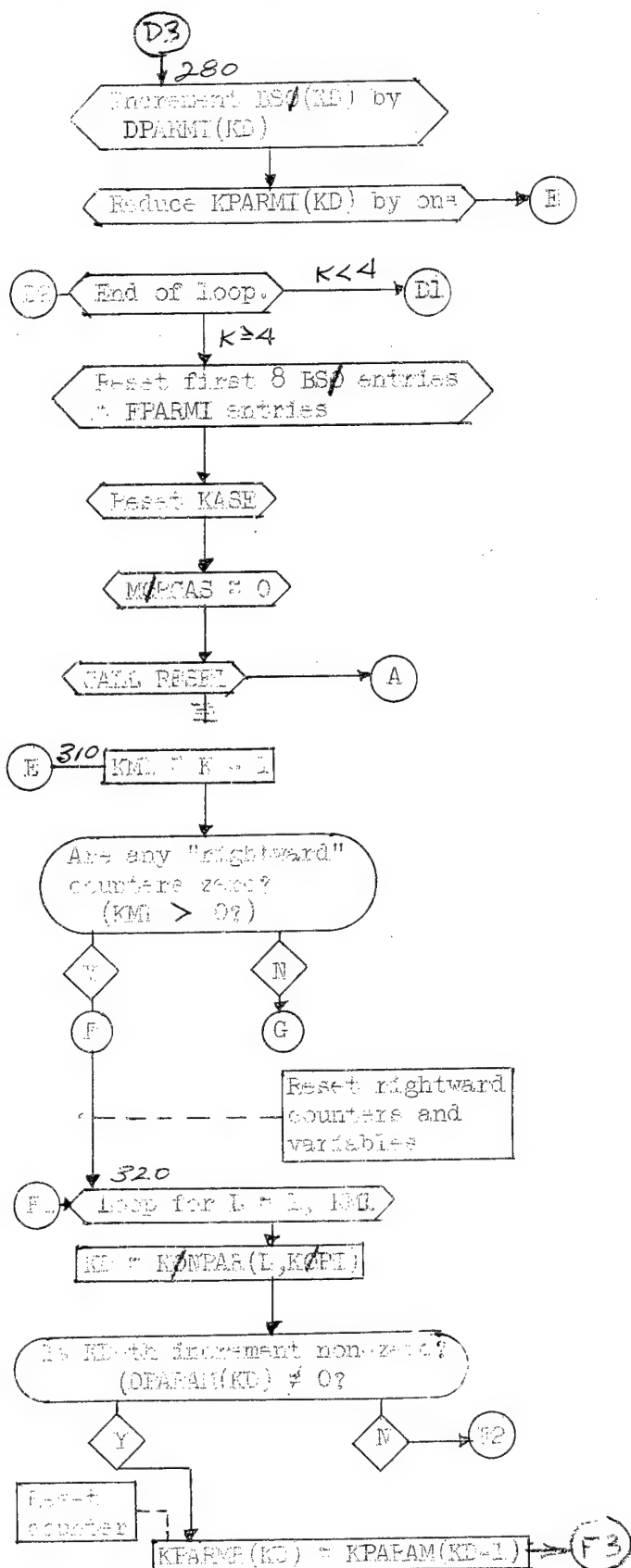


Figure 5 (continued)



APPENDIX A. Thermal Property Functions

The following temperature-dependent functions are required by GFP:

Viscosity	VISC
Thermal conductivity	TC
Specific heat ratio (c_p/c_v)	GAM
Prandtl Number	PRN
Enthalpy	TMPENT(+1 mode)

In addition, temperature as a function of enthalpy is required in order to compute bulk temperature levels. All properties employ the appropriate units from a lbm, sec, inch, BTU, and deg R system except for viscosity which, as a result of an unfortunate act of expediency in the past, is used in lbm/ft-sec.

All properties are encoded as Fortran II functions in the form of polynomials determined from least-squares curve fits and all have as the final argument in their lists the variable GAS. The sources of data are included in the source deck listings. GAS is a floating point variable which designates the gas whose property is to be calculated according to the following table:

Value	Gas	Available
1	Air	X
2	Nitrogen (N_2)	
3	CO ₂	
4	Hydrogen (H_2)	X
5	Oxygen O ₂	
6	Helium	X
7	Argon	
8	Freon	
9	Neon	X

Only those gases marked with X's have properties available, except for the relatively minor gas constant function R. Additional gases can be readily incorporated.

With the exception of the temperature-enthalpy functions which will be discussed later, all of the property functions have the following features in common:

- 1) All are "built" for a maximum of a sixth degree polynomial.
- 2) All have tables which give the lower and upper temperature limits for each gas (tables TMPL~~OW~~ and TMPH~~I~~, respectively). If the function is given a temperature which lies outside the limits for a given gas, the function is evaluated at the nearest temperature limit and the subroutine LMP~~RO~~P is called to print out a comment which tells the property, the gas, the temperature limits, and what temperature was tried.

- 3) If a given function is given a value of GAS for which it does not have a property polynomial, the subroutine ~~NPRPP~~ is called to print out the property name and the gas and the property is evaluated for air.

The TMPENT function is used to calculate enthalpy as a function of temperature (+ mode) and temperature as a function of enthalpy (- mode). The least-squares curve-fits used are based on the same data; the first with temperature as the independent variable and the latter with enthalpy as the independent variable. Since neither curve fit is "perfect" for the data, one cannot assume a temperature, calculate the enthalpy, and use the calculated enthalpy to recompute the original temperature.

In order to avoid this discrepancy, a root-finding technique was employed for the TMPENT function when computing temperatures.

The basic equation used to calculate enthalpy as a function of temperature (and in all other property functions except TFRMEN) can be written as

$$y = \sum_{n=0}^6 a_n T^n \quad (A-1)$$

where T represents absolute temperature and y is the appropriate dependent property. The inverse curve-fit used as a starting point in the calculation of temperature from enthalpy, can be written as

$$T = \sum_{n=0}^6 b_n y^n \quad (A-2)$$

The problem of determining temperature from enthalpy is facilitated by defining a function f, one whose roots is to be determined, by

$$f = y_i - y_i^* \quad (A-3)$$

where y_i^* is the input enthalpy value. The desired value of temperature (which makes $f \approx 0$) is obtained by the Newton-Raphson method using the following formula for the $i+1$ -th improvement to the i -th value of the temperature:

$$T_{i+1} = T_i - \frac{f_i}{\left(\frac{df}{dT}\right)_i} \quad (A-4)$$

Equation (A-2) is used for the first cut on temperature, as noted. The derivative needed by formula (A-4) can be computed as

$$\frac{df}{dT} = \frac{dy}{dT} = \sum_{n=1}^6 n a_n T^{n-1} \quad (A-5)$$

Iteration is halted when the difference between successive approximations become less than or equal to 0.049 degrees.

No temperature limits have been installed in the temperature-enthalpy functions. This decision has been made with some reluctance since it does allow a program user to exceed the valid bounds of the functions. However, a limit cutoff of the same type as installed in the other property functions would invalidate the temperature scale utilization of

Appendix A (continued)

the enthalpy-temperature relationships. A better arrangement, which the writer recommends to anyone who undertakes revision of the program, would be to have the LMPROP subroutine print out its warning when the allowable range of the enthalpy-temperature correlations is exceeded, but to allow the evaluations to be performed at the requested temperature, rather than at the nearest temperature limit.

IDENTIFICATION:

Storage to Tape Hollerith
J. A. Delaney
GE-ANP - Evendale
November 17, 1959

PURPOSE:

To write a BCD record on tape for off-line printing and perform the following:

1. Examine column 1 for a legal carriage control character and space the printer accordingly.
2. Count the number of lines printed on a page and cause the printer to restore the paper after reaching the maximum of 55 lines. Thus, print-out over the perforation is avoided.
3. Automatically number the pages.
4. Automatically print a heading, if one has been specified, at the top and bottom of each page.
5. Supply to the program the number of lines already printed on the current page.
6. Supply the current page number to the program.

USAGE:

This subroutine may be inserted in any FORTRAN II deck and will automatically provide features 1, 2, and 3 above.

STHA retains the function of the subroutines CALL LINES, CALL PAGES, and CALL REST of the version of (STH) written by W. F. COOK, FPD, April 23, 1959.

For a description of the other features, see the supplementary write-up.

LIMITATIONS:

1. Assumes the ANP standard 720 paper tape for printer control. (See supplementary write-up.)

STHA

2. Uses the following names as entry points:

HDING, RESTO, NOPAGE, NOHEAD, NEWSSET, LINES, PAGES, COLUMN, BOTTOM, ANPIPM

To use STHA in an existing program which employs one of the above names for another subprogram, place STHA in the deck prior to the others. If the FORTRAN BSS loader finds more than one program with some particular name, the last program of that name loaded is the one executed.

3. For best results, the new version of the FORTRAN post mortem (called MEMD) should be used with STHA. If the older version PM is used, spacing may be off during the printout of the PM list and extra restores may occur. However, the spacing will correct itself after returning to the program from PM.

STORAGE REQUIRED:

STHA uses 554 words of storage.

NOTE: STHA has two control cards, identified STHA CON1 and STHA CON2. This was necessary because there is not enough space on one card to list all the entry points.

msp

USE OF OPTIONS IN STHA

I. SOURCE LEVEL - Once one of the subroutines 1 through 7 is called, it remains in effect until some future specifications is called to override it.

1. CALL COLUMN (N)

If $N \neq 72$, page numbering will be at the right-hand corner of 120 column printout.

If $N = 72$, page numbering will be at the right-hand corner of 72 column printout.

If no CALL COLUMN is used, 72 column printout will be assumed.

2. CALL NEWSET (N) - The next page will be numbered N. (This will also reset an indicator to print page numbers.)

3. CALL NOPAGE - Page numbering will be omitted.

4. CALL LINES (NL) - The number of lines already printed on the current page is returned as the value for NL.

5. CALL PAGES (NP) - The current page number is returned as the value for NP.

6. CALL HDING () - When mention is made below of a 72 or 120 character heading, it is assumed that column 1 is not available, since that character is for carriage control. The subroutine will ignore the character specified for column 1 and insert the proper carriage control character.

a. CALL HDING (B) - This specifies a heading for printout. B is the name of the lowest memory location of a 12 or 20 word vector (72 or 120 characters) of Hollerith information, which subsequently will be printed at the top and bottom of each page. If page numbering is taking place, the last 12 characters of the 72 or 120 character heading are not printed at the top of the page since this space is reserved for "PAGE XXX." The full 72 or 120 characters are available, however, at the bottom of the page, and so to avoid undesirable information there, a full 72 or 120 character heading must be specified even if the last 12 characters are blank.

An example of a 120 character heading is

```
DIMENSION A(20)
EQUIVALENCE (A(2),B2),(A(11),B11),(A(20),B)
CALL HDING (B)
CALL COLUMN (120)
READ DIP B, B11, B2
```

The DIP input cards would be, (starting in column 1)

2B,9, 1st 54 heading characters
2B11,9, next 54 heading characters
2B2, 12

(The last 12 characters are used for page numbering at the top, and are desired to be blank at the bottom.)

For 72 column output, an example is, (starting in column 1)

DIMENSION A(12)
EQUIVALENCE (A(6),B6),(A(12),B)
CALL NØPAGE
CALL HDING (B)
READ DIP B, B6

DIP cards, (starting in column 1)

2B,6, 1st 36 characters
2B6,6, next 36 heading characters

(All 72 columns are available since no page numbering will occur.)

NOTE: Although CALL HDING (B) may be used prior to the READ DIP statement which reads in the heading, care should be taken that no output statement requiring a new page occurs between the two. Otherwise, the present contents of B, probably all zeros, will be used as the heading.

- b. CALL HDING(120H...(heading)...) or
CALL HDING(72H...(heading)...) or

This alternate form may be used if the heading is known at source time.

7. CALL NØHEAD - A heading will not be printed unless one is later specified. This option is for omitting a heading that has been previously specified.
8. CALL RESTØ - The paper will be restored before the next line is printed.
9. CALL BOTØM - The paper is spaced to the bottom of the page and the heading printed there, if one has been specified.
10. Illegal Control Characters - If X, the character in column 1, is not one of the standard control characters, a 0 (double space) will be assumed. Following this, a note will be printed out as follows:

CONTROL CHARACTER *X* OF PRECEDING LINE IS NOT LEGAL

11. Legal Carriage Control Characters - The ANP standard carriage controls are

0	double space before printing
blank	single space before printing
+	no space before printing
1	restore before printing
2	skip up to 18 lines before printing
4	skip up to 6 lines before printing
8	skip to last line before printing

The characters 2 and 4 are used to skip to the last line of a certain fraction of the page. Control 2 will skip to the bottom of the current 1/3 of the page. That is, if the control character is 2, the line will be printed on line 19, 37, or 55, whichever comes first. Similarly, a control character 4 will skip to the bottom of the current 1/9 of the page. That is, printout will occur on line 7, 13, 19, 25, 31, 37, 43, 49, or 55, whichever comes first.

If there are no lines left on a page corresponding to a 2 or 4 control, i.e., either:

- a. line 55 has been printed; or
- b. the bottom heading is to be printed in line 55, and line 55 would correspond to the control,

the character 2 or 4 will have the same effect as a control character 1.

12. Standard Page - Of the 66 lines per page, 11 will be used for margin at top and bottom, leaving 55 lines per page for printout. If a heading has been specified, it will be printed on lines 1 and 55, leaving lines 2 through 54 available for 53 lines of print. If no heading has been specified, the page number will appear on line 1, leaving lines 2 through 55 available for 54 lines of print.

If CALL NOPAGE has been used, lines 1 through 55 will be used for 55 lines of print.

11. OBJECT LEVEL - Many of the options discussed on the source level above may be used quite easily on the object level for existing programs if DIP is used.

In the following, "(STH)" is the location listed by MEMAP, that is, the entry point.

1. COLUMN - If 120 column page numbering is desired, read a non-zero value into (STH) + 1.
2. NEWSET - To reset the page counter, read an integer N into (STH) + 3 and a non-zero value into (STH) + 2. Then the next page will be numbered N.
3. NOPAGE - Read zero into (STH) + 2.
4. HDING - A 72 or 120 character heading may be read (in BCD) into memory beginning at (STH) + 11₈ = (STH) + 9₁₀.
5. NOHEAD - Read zero into (STH) + 4.

Appendix B (continued)

```
1SL  FORTRA
*SAMPLE CASE FOR STHA
      DIMENSION A(20),C(50)
      EQUIVALENCE(A(20),B),(A(11),B2),(A(2),B22)
110  DO120I=1,50
120  C(I)=I
130  WRITE OUTPUT TAPE 3,1000,(C(I),I=1,50)
140  CALL HDING(B)
150  CALL NEWSET(10)
160  CALL COLUMN(120)
      READ DIP B,B2,B22,D
170  CALL RESTO
180  WRITE OUTPUT TAPE 3,1000,(C(I),I=1,50)
190  WRITE OUTPUT TAPE 3,1001,D
200  CALL BOTTOM
      CALL NOPAGE
      WRITE OUTPUT TAPE 3,1000,(C(I),I=1,50)
210  STOP
1000  FORMAT(1H01PE14.5)
1001  FORMAT(1H71PE14.5)
      END(0,1,0)
R      LOAD AND GO
2B,9,
2B2,9,READ WITH DIP
2B22,2,NOV. 24 1959
=D,12345,
HEADING
```

Write Output Tape Subroutine - FORTRAN II

E. W. Klingenberg

GE-ANP - Evendale

September 1, 1959

Purpose:

To convert either a PRINT statement or a WRITE OUTPUT TAPE statement into the equivalent of both of these statements and to allow for the standard GE-ANPD sense switch 3 convention for output automatically if so desired.

Usage:

CALL WOT (N)

The WOT subroutine will control all PRINT and/or WRITE OUTPUT TAPE statements in the program which occur logically after the first use of the WOT subroutine, even when these output statements are in a different subroutine than the one which called WOT. The argument used will apply until another CALL WOT (N) statement is used to change the argument to another value. Either an integer or an integer variable may be used for the argument, thus allowing the programmer to fix the output or to place it under control of an input code word. By using a CALL WOT (N) statement with a different integer variable in the argument prior to each set of output, complete control of each set of output may be made a function of input. Regardless of whether a PRINT or a WRITE OUTPUT TAPE statement was used, output will be given on tape 3 EXCLUSIVELY and/or the printer according to the following

<u>Argument of WOT</u>	<u>Tape 3</u>	<u>Output on Printer</u>
1	yes	yes
2	yes	If SW3 down
3	yes	no
4	If SW3 up	yes
5	If SW3 up	If SW3 down
6	If SW3 up	no
7	no	yes
8	no	If SW3 down
9	no	no

This subroutine requires four other subroutines to be in the deck, viz., (LEV), (FIL), (SPH), and (STH).

APPENDIX C. A Curve Fit for Transitional Nusselt Numbers

The treatment described was devised by R. T. Lancet and appeared originally in an internal General Electric Company report.

The form of the fitting equation chosen is given in equation (21) and repeated below.

$$\ln \eta = \frac{A}{N_{Re}} + B N_{Re} + C = \ln \left(\frac{N_{Nu}}{N_{Pr}^{1/3} N_{Re}} \right) \quad (C-1)$$

As was discussed previously, the three coefficients are to be determined so that the Nusselt Numbers match at the boundaries of the transition region and so that the transitional Nusselt Number pairs smoothly into the turbulent values. The latter condition can be expressed for the present purposes as

$$\left. \frac{\partial \left[\ln \left(\frac{N_{Nu,T}}{N_{Pr,T}^{1/3} N_{Re,T}} \right) \right]}{\partial [\ln N_{Re}]} \right|_{\text{transition}} = \left. \frac{\partial \left[\ln \left(\frac{N_{Nu,T}}{N_{Pr,T}^{1/3} N_{Re,T}} \right) \right]}{\partial [\ln N_{Re,T}]} \right|_{\text{transition}} \quad (C-2)$$

Using the form of the Nusselt Number correlation shown in equation (17) and introducing the symbol α for convenience, we can write

$$\alpha = \frac{N_{Nu}}{N_{Pr}^{1/3} N_{Re}} = a_T N_{Pr,T}^{(C_T - 1/3)} N_{Re,T}^{(C_T - 1)} \quad (C-3)$$

Taking first the logarithm and then the derivative, there results

$$\ln \alpha = \ln a_T + (C_T - 1/3) \ln N_{Pr,T} + (C_T - 1) \ln N_{Re,T} \quad (C-4)$$

$$\frac{\partial \ln \alpha}{\partial \ln N_{Re,T}} = C_T - 1 \quad (C-5)$$

Rewriting equation (C-1) for convenience and taking the derivative yields

$$\begin{aligned} \frac{\partial \ln \eta}{\partial \ln N_{Re}} &= \frac{\partial}{\partial \ln N_{Re}} \left[\frac{A}{e^{\ln N_{Re,T}}} + B e^{\ln N_{Re,T}} + C \right] \\ &= -\frac{A}{e^{\ln N_{Re,T}}} + B e^{\ln N_{Re,T}} = -\frac{A}{N_{Re}} + B N_{Re} \end{aligned} \quad (C-6)$$

Equating (C-5) and (C-6) yields one of the necessary algebraic equations,

$$-\frac{A}{N_{Re,T}} + B N_{Re,T} = C_T - 1 \quad (C-7a)$$

Appendix C (continued)

Direct substitution of the transition Reynolds Numbers into equation (C-1) yields the other two algebraic equations,

$$\ln \eta_0 = \frac{A}{N_{Re0}} + B N_{Re0} + C \quad (C-7b)$$

$$\ln \eta_1 = \frac{A}{N_{Re1}} + B N_{Re1} + C \quad (C-7c)$$

The solution of equations (C-7) for the coefficients A, B, and C yields the values given in equation (22).

* * * * *	0001 66
* GENERAL FLOW PASSAGE (ANP 663) COMPLETE SOURCE DECK 4/28/61	0002 66
*GFP 663 GENERAL FLOW PASSAGE	0003 66
* A PROGRAM TO CALCULATE ONE-DIMENSIONAL COMPRESSIBLE	0004 66
* PRESSURE DROP AND SURFACE TEMPERATURES	0005 66
*	0006 66
* S C SKIRVIN	0007 66
*HAS AUTOMATIC CALCULATION OPTIONS CONTROLLED BY AVAIL-	0008 66
* ABLE INPUT DATA - WT FLOW ITERATED TO SATISFY	0009 66
* TWMAX OR EXIT PRES	0010 66
*	0011 66
*BEGIN STORAGE MAP	0012 66
* * * MASTER GROUPING	0013 66
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	0014 66
1BG(5474)	0015 66
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	0016 66
COMMON BG	0017 66
* * * END OF MASTER GROUPING	0018 66
EQUIVALENCE(PRTSUM,BG0(49)),(DEAD,BG0(13)),(KALCNO,BG0(27)),	0019 66
1(NOPRT,BG0(46)),(NOINPT,BG0(66))	0020 66
2,(MORCAS,BG0(41))	0021 66
EQUIVALENCE(PDYIN,BG0(73)),(PDYEX,BG0(74)),(OMINLT,BG0(83)),	0022 66
1(OMEXIT,BG0(84)),(DPIN,BG0(85)),(DPEX,BG0(86))	0023 66
2,(TRANSF,BG0(87)),(TRANHL,BG0(88)),(TRANHU,BG0(89))	0024 66
3,(NEWSET,BG0(90)),(KTPAR,BG0(91)),(KTOTPR,BG0(92)),(QBAR,BG0(93)),	0025 66
4(QOQBAR,BG0(94)),(NOGEOM,BG0(95))	0026 66
EQUIVALENCE(HEADER,HEDDUM(12))	0027 66
EQUIVALENCE(HEDDUM,BG1(974))	0028 66
*END OF STORAGE MAP	0029 66
*	0030 66
CALL WOT(5)	0031 66
CALL HDING(HEADER)	0032 66
*IS THIS FIRST ENTRY	0033 66
IF(KFIRST-9999)90,80,90	0034 66
*NOT FIRST ENTRY - IS SL 1 ON	0035 66
80 IF(SENSE LIGHT 1)82,84	0036 66
*NORMAL SR ERROR RETURN	0037 66
82 DEAD=1.	0038 66
GO TO 300	0039 66
*REASON FOR SECOND ENTRY NOT KNOWN	0040 66
84 CALL NETERR(99,99)	0041 66
GO TO 82	0042 66
*NORMAL FIRST ENTRY	0043 66
90 KFIRST=9999	0044 66
*TURN SENSE LIGHTS OFF	0045 66
SENSE LIGHT 0	0046 66
*PERFORMS PRE-LOAD INITIALIZATION	0047 66
--100 CALL INITAL	0048 66
*	0049 66
*READS INPUT DATA	0050 66
300 CALL READIN	0051 66

*IS A SUMMARY PRINT WANTED	0052 663
IF(PRTSUM)400,400,900	0053 663
*NORMAL SEQUENCE - PROCESS INPUT DATA	0054 663
400 CALL DATPRO	0055 663
*CHECK INPUT CONSISTENCY AND ADEQUACY	0056 663
500 CALL CONSIS	0057 663
*CHECK IF ERROR FOUND	0058 663
IF(DEAD)600,560,600	0059 663
*CHECK IF FIRST CALC	0060 663
560 IF(KALCNO)600,600,570	0061 663
*IS ALL PRINTOUT TO BE SUPPRESSED	0062 663
570 IF(NOPRT)580,580,700	0063 663
*IS INPUT PRINTOUT TO BE SUPPRESSED	0064 663
580 IF(NOINPT)600,600,700	0065 663
*PRINT INPUT DATA	0066 663
600 CALL INPPRT	0067 663
*WAS AN ERROR FOUND	0068 663
IF(DEAD)700,700,300	0069 663
*CARRY OUT CALCULATION OPTION	0070 663
700 CALL ITRCON	0071 663
*DID ITERATION FAIL	0072 663
IF(SENSE LIGHT 2)710,760	0073 663
710 SENSE LIGHT 2	0074 663
IF(MORCAS)760,800,760	0075 663
*IS PRINTOUT COMPLETELY SUPPRESSED	0076 663
760 IF(NOPRT)800,800,860	0077 663
*PRINT RESULTS	0078 663
800 CALL OUTPUT	0079 663
860 IF(MORCAS)865,870,865	0080 663
865 KTPAR=KTPAR+1	0081 663
IF(KTOTPR-KTPAR)900,900,870	0082 663
*IS THIS ONE-HUNDREDTH CALC	0083 663
870 IF(100-KALCNO)900,900,1000	0084 663
*MAKE SUMMARY PRINTOUT	0085 663
900 CALL SUMPRT	0086 663
*WAS THIS PRINTOUT A DIRECT REQUEST	0087 663
IF(PRTSUM)960,1000,960	0088 663
960 PRTSUM=0.	0089 663
GO TO 300	0090 663
*IS THIS A PARAMETRIC CASE	0091 663
1000 IF(MORCAS)1010,1010,300	0092 663
*RESET CALC DATA FIELDS WHERE NECESSARY FOR CHANGE CASE	0093 663
1010 CALL RESET	0094 663
*RETURN FOR CHANGE CASE	0095 663
GO TO 300	0096 663
END(0,1,0)	0097 663
* * * * *	0098 663
*CONSIS SR TO CHECK CONSISTENCY AND ADEQUACY OF	0099 663
* INPUT DATA AND SET CALCULATION OPTION FOR	0100 663
*GFP 663 GENERAL FLOW PASSAGE	0101 663
* S C SKIRVIN	0102 663
*	0103 663
* SETS DEAD=1. IF ANY ERROR FOUND, BUT ALWAYS	0104 663
* LOOKS FOR ALL ERRORS	0105 663
* SUBROUTINE CONSIS	0106 663
*	0107 663
*BEGIN STORAGE MAP	0108 663

*GENERAL USAGE

DIMENSION

1AFFI (100),BSI (11),BSO (11),CLOSSI(100),CLSGEN(100), 0109 663
 2CLSM DI(100),DHI (100),DPARAM(8),DPARMI(8),FMULTI(100), 0110 663
 3FTABI (8),FPARMI(8),HTABI (6),HMULTI(100),KRSCON(4), 0111 663
 4KPARAM(8),KPARMR(8),NDH (100),NAFL (100),NLEN (100), 0112 663
 5NCLOSS(100),NCLSM DI(100),NRINGD(100),NHMULT(100),NFMULT(100), 0113 663
 6OLENI (100),PHISUM(100),PHIEX (100),PO (100),P1 (100), 0114 663
 7P2 (100),THICKD(100),TEXI (100),XOLD (100),BHIGH (12), 0115 663
 8HEDDUM(12),GMASS (100),TW (100),REYNO (100),FRIC (100), 0116 663
 9CONVEC(100),DPINT(100),OMEXI(100),PRTGAS(9) 0117 663

DIMENSION PSEXI(100),PDYEXI(100),PEXI(100)

*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP

EQUIVALENCE

1(AD ,BG0(1)),(ACCMNO,BG0(2)),(ACCPRS,BG0(3)) , 0118 663
 2(ACCTMP,BG0(4)),(ALLRUN,BG0(5)),(AUTOLS,BG0(6)) , 0119 663
 3(BD ,BG0(7)),(BLANKS,BG0(8)),(BETA1 ,BG0(9)) , 0120 663
 4(BETA2 ,BG0(10)),(CIN ,BG0(11)),(CEX ,BG0(12)) , 0121 663
 5(DEAD ,BG0(13)),(DELH ,BG0(14)),(DERIV ,BG0(15)) , 0122 663
 6(ENTRN ,BG0(16)),(ENTRNC,BG0(17)),(FD ,BG0(18)) , 0123 663
 7(FTIN ,BG0(19)),(FTOUT ,BG0(20)),(FSTPAR,BG0(21)) , 0124 663
 8(GOAL ,BG0(22)),(GAS ,BG0(23)),(HIN ,BG0(24)) , 0125 663
 9(ITRY ,BG0(25)),(KTRCRD,BG0(26)),(KALCNO,BG0(27)) , 0126 663

EQUIVALENCE

1(KTCHAD,BG0(28)),(KTWADJ,BG0(29)),(KTCHTO,BG0(30)) , 0127 663
 2(KPOW ,BG0(31)),(KOPT ,BG0(32)),(KOSCIL,BG0(33)) , 0128 663
 3(KCHOKE,BG0(34)),(KASE ,BG0(35)),(KASTEP,BG0(36)) , 0129 663
 4(LOC ,BG0(37)),(LIMCHK,BG0(38)),(LMCHTO,BG0(39)) , 0130 663
 5(LIMTRY,BG0(40)),(MORCAS,BG0(41)),(NSKPPR,BG0(42)) , 0131 663
 6(NSKPHT,BG0(43)),(NT ,BG0(44)),(NHOT ,BG0(45)) , 0132 663
 7(NOPRT ,BG0(46)),(NOSTGE,BG0(47)),(PARPRT,BG0(48)) , 0133 663
 8(PRTSUM,BG0(49)),(RNKIN ,BG0(50)),(RNKOUT,BG0(51)) , 0134 663
 9(SVACMN,BG0(52)),(SVACPR,BG0(53)),(TOTLND,BG0(54)) , 0135 663

EQUIVALENCE

1(TRY0 ,BG0(55)),(TRY1 ,BG0(56)),(TRY2 ,BG0(57)) , 0136 663
 2(TRY3 ,BG0(58)),(TEST1 ,BG0(59)),(TOTLEN,BG0(60)) , 0137 663
 3(WHI ,BG0(61)),(WLO ,BG0(62)),(YIELD0,BG0(63)) , 0138 663
 4(YIELD1,BG0(64)),(YIELD2,BG0(65)),(NOINPT,BG0(66)) , 0139 663
 5(LIMPRS,BG0(67)),(PRTALL,BG0(68)),(OMAXD ,BG0(69)) , 0140 663
 6(OMAX,BG0(70)),(OMAX1,BG0(71)),(KOPTH,BG0(72)) , 0141 663

7 (DMCONV,BG0(75)),(KDI,BG0(76)),(KDD,BG0(77)),(TRYMAX,BG0(78)) , 0142 663
 878)),(MAXTMP,BG0(79)),(LMBULK,BG0(80)),(TBBULK,BG0(81)) , 0143 663

9(KCHK1,BG0(1)),(KCHK2,BG0(7)),(KCHK3,BG0(18)),(KGAS,BG0(82)) , 0144 663
 EQUIVALENCE(PDYIN,BG0(73)),(PDYEX,BG0(74)),(OMINLT,BG0(83)) , 0145 663

1(OMEXIT,BG0(84)),(DPIN,BG0(85)),(DPEx,BG0(86)) , 0146 663
 2,(TRANSF,BG0(87)),(TRANHL,BG0(88)),(TRANHU,BG0(89)) , 0147 663

3,(NEWSET,BG0(90)),(KTPAR,BG0(91)),(KTOTPR,BG0(92)),(QBAR,BG0(93)) , 0148 663
 4(QOQBAR,BG0(94)),(NOGEOM,BG0(95)) , 0149 663

EQUIVALENCE

1(AFFD ,BG1(2)),(AFFI ,BG1(102)),(BSI ,BG1(202)) , 0150 663
 2(BSO ,BG1(213)),(BHIGH ,BG1(224)),(CLOSSI,BG1(237)) , 0151 663
 3(CLSGEN,BG1(337)),(CLSM DI,BG1(438)),(DHD ,BG1(539)) , 0152 663
 4(DHI ,BG1(639)),(DPARAM,BG1(739)),(DPARMI,BG1(747)) , 0153 663
 5(FTABI ,BG1(755)),(FPARMI,BG1(759)),(FMULTI,BG1(768)) , 0154 663
 6(GMASS ,BG1(868)),(HTABI ,BG1(968)),(HEDDUM,BG1(974)) , 0155 663
 7(HMULTI,BG1(987)),(KPARAM,BG1(1087)),(KPARMR,BG1(1095)) , 0156 663
 8(KRSCON,BG1(1103)),(NDH ,BG1(1107)),(NAFL ,BG1(1207)) , 0157 663

9(NLEN ,BG1(1307)),(NCLOSS,BG1(1407)),(NCLSMDBG1(1507))	0166 663
EQUIVALENCE	0167 663
1(NHMULT,BG1(1607)),(NFMULT,BG1(1707)),(OLENDBG1(1808)),	0168 663
2(OLENI ,BG1(1908)),(PHISUMBG1(2008)),(PHIEX ,BG1(2108)),	0169 663
3(PO ,BG1(2208)),(P1 ,BG1(2308)),(P2 ,BG1(2408)),	0170 663
4(TEXI ,BG1(2508)),(TW ,BG1(2608)),(XOLDBG1(2708)),	0171 663
5(XOL ,BG1(2808)),(REYNO ,BG1(2908)),(FRIC ,BG1(3008)),	0172 663
6(CONVECBG1(3108)),(DPINT,BG1(3208)),(OMEXI,BG1(3308))	0173 663
7,(PRTGAS,BG1(3408)),(PSEXI,BG1(3417)),(PDYEXI,BG1(3517))	0174 663
*OPEN AT 3617, KEEP OPEN UNTIL 3700	0175 663
DIMENSION KONOPT(2,10),KONPAR(4,13),SAVTAB(13,100),KSVTAB(13,100)	0176 663
EQUIVALENCE(KONOPT,KUP,BG2),(KONPAR,BG2(21)),	0177 663
1(SAVTAB,KSVTAB,BG2(73))	0178 663
*OPEN 1373	0179 663
EQUIVALENCE(THICKD,BG3(2)),(NRINGD,BG3(103)),(PEXI,BG3(203))	0180 663
*	0181 663
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2)),(COFFTB,	0182 663
1FTABI(3)),(EXPFTB,FTABI(4))	0183 663
*	0184 663
*BASIC OPTIONAL VARIABLES	0185 663
DIMENSION GRTMPI(3),GRTMPO(3)	0186 663
EQUIVALENCE(PIN,BSI),(TIN,BSI(2)),(TEX,BSI(3)),(TWMAX,	0187 663
1BSI(4)),(PSEX,BSI(5)),(PEX,BSI(6)),(W,BSI(7)),(QTOT,	0188 663
2BSI(8)),(PIND,BSO),(TIND,BSO(2)),(TEXD,BSO(3)),(TWMAXD,	0189 663
3BSO(4)),(PSEXDBSO(5)),(PEXDBSO(6)),(WD,BSO(7)),(QTOTD,	0190 663
4BSO(8)),(PSXOPI,BSI(9)),(PTXOPI,BSI(10)),(TEXOTI,BSI(11)),	0191 663
5(PSPID,BSO(9)),(PTPID,BSO(10)),(TXTID,BSO(11)),	0192 663
6(GRTMPI,BSI(2)),(GRTMPO,BSO(2))	0193 663
*	0194 663
EQUIVALENCE(COFHLM,HTABI),(EXHPLM,HTABI(2)),(EXHRLM,	0195 663
1HTABI(3)),(COFHTEHTABI(4)),(EXHPTB,HTABI(5)),(EXHRTB,	0196 663
2HTABI(6))	0197 663
EQUIVALENCE(DPTIN,DPARAM),(DTTIN,DPARAM(2)),(DTTEX,DPARAM(3)),	0198 663
1(DTWMAX,DPARAM(4)),(DPSEX,DPARAM(5)),(DPTEX,DPARAM(6)),(DW,DPARAM(	0199 663
27)),(DQTOT,DPARAM(8)),(NOPTIN,KPARAM),	0200 663
3(NOTTIN,KPARAM(2)),(NOTTEX,KPARAM(3)),(NOTWMX,NTWMAX,NOTWA,	0201 663
4KPARAM(4)),(NOPSEX,KPARAM(5)),(NOPTEX,KPARAM(6)),(NOW,KPARAM(7)),	0202 663
5(NOQTOT,KPARAM(8))	0203 663
*	0204 663
*LIMITED USEAGE	0205 663
DIMENSION AFFD(100),DHD(100),OLEND(100),XOL(100)	0206 663
EQUIVALENCE(AFFD,AFF(2)),(CLOSSI,CLOSS(2)),(CLSMDBCLSMOD(2)),	0207 663
1(DHD,DH(2)),(DH,DOUTER,ELPMAJ,WIDTH),(AFF,DINNER,ELPMIN,	0208 663
2HEIGHT),(FMULTI,FMULT(2)),(HMULTI,HMULT(2)),(ROUND,KRSCON),	0209 663
3(RECTNG,KRSCON(2)),(ELLIPS,KRSCON(3)),(RINGS,KRSCON(4)),	0210 663
4(OLEND,LENGTH(2)),(NRINGD,NORING(2)),(NAFF,NAFL),(THICKD,	0211 663
5THICK(2)),(PTIN,PIN),(TTIN,TIN),(PTEX,PEX),(TEX,TTEX),	0212 663
6(CASE,KASE),(CASTEP,KASTEP),(DHD,DHG),(DH,DHGSUB),(AFF,	0213 663
7AFFSUB),(OLEND,OL),(LENGTH,OLSUB),(ACCMNO,PER),(NOSTGE,MN),	0214 663
8(HTABI(4),A1),(FTABI(3),B1),(FTABI(4),OM),(FMULTI,AKF),(HMULTI,	0215 663
9AKH),(CIN,C1),(CEX,C2),(PHISUM,A2),(PHIEX,Q),(NLEN,NOL)	0216 663
EQUIVALENCE(NDH,NDHG),(MAXMNO,OMAXD)	0217 663
*ALL MODIFIED OFF-DESIGN(ANP 443) INPUT VARIABLES	0218 663
* ARE IN DIP LIST, FUNCTIONALLY WHEREVER POSSIBLE	0219 663
*	0220 663
* * * MASTER GROUPING	0221 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	0222 663

1BG(5474)	0223 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	0224 663
COMMON BG	0225 663
* * * END OF MASTER GROUPING	0226 663
DIMENSION KOPSET(3,13),BSOD(8)	0227 663
TABLE KOPSET(1,4,8, 1,4,3, 1,5,8, 1,5,3, 1,6,8, 1,6,3,	0228 663
17,5,8, 7,5,3, 7,6,8, 7,6,3, 7,1,8, 7,1,3, 1,8,3)	0229 663
*END OF STORAGE MAP	0230 663
*	0231 663
NOSTGE=NOSTGE	0232 663
*IS THIS A PARAMETRIC STUDY	0233 663
IF(MORCAS)90,90,80	0234 663
*IS THIS FIRST PARAMETRIC PASS	0235 663
80 IF(FSTPAR)1080,1080,90	0236 663
*EITHER NON-PARAM OR FIRST PASS	0237 663
90 CONTINUE	0238 663
*CHECK XOL STAGE LENGTH INPUT	0239 663
IF(TOTLEN)100,170,100	0240 663
100 NOXOL=1	0241 663
DO 130 N=2,NOSTGE	0242 663
IF(XOL(N)-XOL(N-1))110,130,120	0243 663
110 CALL NETERR(108,N)	0244 663
DEAD=1.	0245 663
GO TO 130	0246 663
120 NOXOL=0	0247 663
130 CONTINUE	0248 663
IF(NOXOL)140,150,140	0249 663
140 CALL NETERR(108,0)	0250 663
DEAD=1.	0251 663
150 IF(XOL(NOSTGE) 1.)160,170,160	0252 663
160 CALL NETERR(109,0)	0253 663
DEAD=1.	0254 663
170 CONTINUE	0255 663
*CHECK FOR SUFFICIENT DATA	0256 663
440 DO 530 N=1,NOSTGE	0257 663
IF(CLENI(N))490,490,450	0258 663
450 IF(DHI(N))460,460,470	0259 663
460 CALL NETERR(N,1)	0260 663
DEAD=1.	0261 663
470 IF(AFFI(N))480,480,530	0262 663
480 CALL NETERR(N,2)	0263 663
DEAD=1.	0264 663
490 IF(AFFI(N))520,520,530	0265 663
520 CALL NETERR(N,3)	0266 663
530 CONTINUE	0267 663
IF(PIND-PEXD)550,545,550	0268 663
*NO PRES DROP CALC	0269 663
545 NSKPPR=1	0270 663
GO TO 580	0271 663
550 NSKPPR=0	0272 663
555 DO 570 M=1,4	0273 663
IF(FTABI(M))570,560,570	0274 663
560 CALL NETERR(102,M)	0275 663
DEAD=1.	0276 663
570 CONTINUE	0277 663
580 IF(TIND-TEXD)590,585,590	0278 663
*NO HEAT TRANSFER SIGNAL	0279 663

585 NSKPHT=1	0280 663
GO TO 600	0281 663
590 NSKPHT=0	0282 663
600 IF(HTABI(1))620,610,620	0283 663
610 CALL NETERR(103,1)	0284 663
DEAD=1.	0285 663
620 IF(HTABI(4))640,630,640	0286 663
630 CALL NETERR(103,4)	0287 663
DEAD=1.	0288 663
640 CONTINUE	0289 663
650 IF(NSKPPR*NSKPHT)660,670,660	0290 663
NEITHER HEAT TRANSFER NOR PRESSURE DROP REQUIRED	0291 663
660 CALL NETERR(104,104)	0292 663
DEAD=1.	0293 663
670 IF(ENTRNC)720,720,680	0294 663
680 ENTRN=1.	0295 663
IF(BETA1)700,690,700	0296 663
690 CALL NETERR(105,105)	0297 663
700 IF(BETA2)720,710,720	0298 663
710 CALL NETERR(106,106)	0299 663
CHECK FOR QBAR INPUT	0300 663
720 IF(QQBAR)722,726,722	0301 663
722 IF(QBAR)724,726,724	0302 663
724 QTOTD=QQBAR*QBAR	0303 663
QTOT=QTOTD	0304 663
CONSISTENCY AND ADEQUACY CHECKING FINISHED	0305 663
726 CONTINUE	0306 663
IF(NSKPPR)980,730,980	0307 663
730 IF(NSKPHT)980,740,980	0308 663
SET OPTION INDICATOR	0309 663
740 KOPT=0	0310 663
DO 741 L=1,8	0311 663
741 BSOD(L)=BSI(L)	0312 663
IF(PSEX)742,742,744	0313 663
742 IF(PSXOP1)744,744,743	0314 663
743 BSOD(5)=1.	0315 663
744 IF(PEX)745,745,747	0316 663
745 IF(PTXOP1)747,747,746	0317 663
746 BSOD(6)=1.	0318 663
747 IF(TEX)750,748,750	0319 663
748 IF(TEXOTI)750,750,749	0320 663
749 BSOD(3)=1.	0321 663
750 DO 760 J=1,13	0322 663
DO 752 I=1,3	0323 663
ID=KOPSET(I,J)	0324 663
IF(BSOD(ID))752,760,752	0325 663
752 CONTINUE	0326 663
NORMAL EXIT SETS OPTION	0327 663
KOPT=J	0328 663
KOPTH=10-KOPT	0329 663
GO TO 900	0330 663
760 CONTINUE	0331 663
NORMAL EXIT MEANS OPTION CANNOT BE SET	0332 663
790 CALL NETERR(150,1)	0333 663
SENSE LIGHT 3	0334 663
DEAD=1.	0335 663
900 CONTINUE	0336 663

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*OPTION INDICATOR PROCESSING FINISHED                                0337 663
  980 CONTINUE                                                         0338 663
*IS POWER PROFILE PRESENT IF NEEDED                                0339 663
  IF(KPOW)1080,1040,1080                                             0340 663
  1040 IF(NSKPHT)1080,1050,1080                                       0341 663
  1050 CALL NETERR(151,1)                                             0342 663
    DEAD=1.                                                            0343 663
  1080 CONTINUE                                                         0344 663
*FINISHED                                                            0345 663
  RETURN                                                                0346 663
  END(0,1,0)                                                           0347 663
* * * * *                                                             0348 663
*DATPRO  SR TO PROCESS INPUT DATA FOR                             0349 663
*GFP 663  GENERAL FLOW PASSAGE                                       0350 663
*  S C SKIRVIN                                                         0351 663
*                                                                      0352 663
  SUBROUTINE DATPRO                                                    0353 663
*                                                                      0354 663
*BEGIN STORAGE MAP                                                    0355 663
*GENERAL USEAGE                                                       0356 663
  DIMENSION                                                            0357 663
  1AFFI (100 ),BSI (11 ),BSO (11 ),CLOSSI(100 ),CLSGEN(100 ), 0358 663
  2CLSM DI(100 ),DHI (100 ),DPARAM(8 ),DPARM I(8 ),FMULTI(100 ), 0359 663
  3FTABI (8 ),FPARM I(8 ),HTABI (6 ),HMULTI(100 ),KRSCON(4 ), 0360 663
  4KPARAM(8 ),KPARMR(8 ),NDH (100 ),NAFL (100 ),NLEN (100 ), 0361 663
  5NCLOSS(100 ),NCLSM D(100 ),NRINGD(100 ),NHMULT(100 ),NFMULT(100 ), 0362 663
  6OLENI (100 ),PHISUM(100 ),PHIEX (100 ),PO (100 ),P1 (100 ), 0363 663
  7P2 (100 ),THICKD(100 ),TEXI (100 ),XOLD (100 ),BHIGH (12 ), 0364 663
  8HEDDUM(12 ),GMASS (100 ),TW (100 ),REYNO (100 ),FRIC (100 ), 0365 663
  9CONVEC(100 ),DPINT(100 ),OMEXI(100 ),PRTGAS(9)                   0366 663
  DIMENSION PSEXI(100 ),PDYEXI(100 ),PEXI(100)                     0367 663
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP          0368 663
  EQUIVALENCE                                                         0369 663
  1(AD ,BG0(1 )),(ACCMNO,BG0(2 )),(ACCPRS,BG0(3 )) , 0370 663
  2(ACCTMP,BG0(4 )),(ALLRUN,BG0(5 )),(AUTOLS,BG0(6 )) , 0371 663
  3(BD ,BG0(7 )),(BLANKS,BG0(8 )),(BETA1 ,BG0(9 )) , 0372 663
  4(BETA2 ,BG0(10 )),(CIN ,BG0(11 )),(CEX ,BG0(12 )) , 0373 663
  5(DEAD ,BG0(13 )),(DELH ,BG0(14 )),(DERIV ,BG0(15 )) , 0374 663
  6(ENTRN ,BG0(16 )),(ENTRNC,BG0(17 )),(FD ,BG0(18 )) , 0375 663
  7(FTIN ,BG0(19 )),(FTOUT ,BG0(20 )),(FSTPAR,BG0(21 )) , 0376 663
  8(GOAL ,BG0(22 )),(GAS ,BG0(23 )),(HIN ,BG0(24 )) , 0377 663
  9(ITRY ,BG0(25 )),(KTRCRD,BG0(26 )),(KALCNO,BG0(27 )) , 0378 663
  EQUIVALENCE                                                         0379 663
  1(KTCHAD,BG0(28 )),(KTWADJ,BG0(29 )),(KTCHTO,BG0(30 )) , 0380 663
  2(KPOW ,BG0(31 )),(KOPT ,BG0(32 )),(KOSCIL,BG0(33 )) , 0381 663
  3(KCHOKE,BG0(34 )),(KASE ,BG0(35 )),(KASTEP,BG0(36 )) , 0382 663
  4(LOC ,BG0(37 )),(LIMCHK,BG0(38 )),(LMCHTO,BG0(39 )) , 0383 663
  5(LIMTRY,BG0(40 )),(MORCAS,BG0(41 )),(NSKPPR,BG0(42 )) , 0384 663
  6(NSKPHT,BG0(43 )),(NT ,BG0(44 )),(NHOT ,BG0(45 )) , 0385 663
  7(NOPRT ,BG0(46 )),(NOSTGE,BG0(47 )),(PARPRT,BG0(48 )) , 0386 663
  8(PRTSUM,BG0(49 )),(RNKIN ,BG0(50 )),(RNKOUT,BG0(51 )) , 0387 663
  9(SVACMN,BG0(52 )),(SVACPR,BG0(53 )),(TOTLND,BG0(54 )) , 0388 663
  EQUIVALENCE                                                         0389 663
  1(TRY0 ,BG0(55 )),(TRY1 ,BG0(56 )),(TRY2 ,BG0(57 )) , 0390 663
  2(TRY3 ,BG0(58 )),(TEST1 ,BG0(59 )),(TOTLEN,BG0(60 )) , 0391 663
  3(WHI ,BG0(61 )),(WLO ,BG0(62 )),(YIELD0,BG0(63 )) , 0392 663
  4(YIELD1,BG0(64 )),(YIELD2,BG0(65 )),(NOINPT,BG0(66 )) , 0393 663

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5(LIMPRS,BG0(67)),(PRTALL,BG0(68)),(OMAXD,BG0(69)),	0394 663
6(OMAX,BG0(70)),(OMAX1,BG0(71)),(KOPH,BG0(72)),	0395 663
7(DMCONVTBG0(5)DT(KD+,B+0(76D4	
878)),(MAXTMP,BG0(79)),(LMBULK,BG0(80)),(TBBULK,BG0(81)),	0397 663
9(KCHK1,BG0(1)),(KCHK2,BG0(7)),(KCHK3,BG0(18)),(KGAS,BG0(82))	0398 663
EQUIVALENCE(PDYIN,BG0(73)),(PDYEX,BG0(74)),(OMINLT,BG0(83)),	0399 663
1(OMEXIT,BG0(84)),(DPIN,BG0(85)),(DPEX,BG0(86))	0400 663
2,(TRANSF,BG0(87)),(TRANHL,BG0(88)),(TRANHU,BG0(89))	0401 663
3,(NEWSET,BG0(90)),(KTPAR,BG0(91)),(KTOTPR,BG0(92)),(QBAR,BG0(93)),	0402 663
4(QOQBAR,BG0(94)),(NOGEOM,BG0(95))	0403 663
EQUIVALENCE	0404 663
1(AFFD,BG1(2)),(AFFI,BG1(102)),(BSI,BG1(202)),	0405 663
2(BSO,BG1(213)),(BHGH,BG1(224)),(CLOSSI,BG1(237)),	0406 663
3(CLSGEN,BG1(337)),(CLSMID,BG1(438)),(DHD,BG1(539)),	0407 663
4(DHI,BG1(639)),(DPARAM,BG1(739)),(DPARM1,BG1(747)),	0408 663
5(FTABI,BG1(755)),(FPARM1,BG1(759)),(FMULTI,BG1(768)),	0409 663
6(GMASS,BG1(868)),(HTABI,BG1(968)),(HEDDUM,BG1(974)),	0410 663
7(HMULTI,BG1(987)),(KPARAM,BG1(1087)),(KPARMR,BG1(1095)),	0411 663
8(KRSCON,BG1(1103)),(NDH,BG1(1107)),(NAFL,BG1(1207)),	0412 663
9(NLEN,BG1(1307)),(NCLOSS,BG1(1407)),(NCLSMID,BG1(1507))	0413 663
EQUIVALENCE	0414 663
1(NHMULT,BG1(1607)),(NFMULT,BG1(1707)),(OLEND,BG1(1808)),	0415 663
2(OLENI,BG1(1908)),(PHISUM,BG1(2008)),(PHIEX,BG1(2108)),	0416 663
3(PO,BG1(2208)),(P1,BG1(2308)),(P2,BG1(2408)),	0417 663
4(TEXI,BG1(2508)),(TW,BG1(2608)),(XOLD,BG1(2708)),	0418 663
5(XOL,BG1(2808)),(REYNO,BG1(2908)),(FRIC,BG1(3008)),	0419 663
6(CONVEC,BG1(3108)),(DPINT,BG1(3208)),(OMEXI,BG1(3308))	0420 663
7,(PRTGAS,BG1(3408)),(PSEXI,BG1(3417)),(PDYEXI,BG1(3517))	0421 663
*OPEN AT 3617, KEEP OPEN UNTIL 3700	0422 663
DIMENSION KNOPT(2,10),KONPAR(4,13),SAVTAB(13,100),KSVTAB(13,100)	0423 663
EQUIVALENCE(KNOPT,KUP,BG2),(KONPAR,BG2(21)),	0424 663
1(SAVTAB,KSVTAB,BG2(73))	0425 663
*OPEN 1373	0426 663
EQUIVALENCE(THICKD,BG3(2)),(NRINGD,BG3(103)),(PEXI,BG3(203))	0427 663
*	0428 663
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2)),(COFFTB,	0429 663
1FTABI(3)),(EXPFTB,FTABI(4))	0430 663
*	0431 663
*BASIC OPTIONAL VARIABLES	0432 663
DIMENSION GRTMPI(3),GRTMPO(3)	0433 663
EQUIVALENCE(PIN,BSI),(TIN,BSI(2)),(TEX,BSI(3)),(TWMAX,	0434 663
1BSI(4)),(PSEX,BSI(5)),(PEX,BSI(6)),(W,BSI(7)),(QTOT,	0435 663
2BSI(8)),(PIND,BSO),(TIND,BSO(2)),(TEXD,BSO(3)),(TWMAXD,	0436 663
3BSO(4)),(PSEXID,BSO(5)),(PEXID,BSO(6)),(WD,BSO(7)),(QTOTD,	0437 663
4BSO(8)),(PSXOPI,BSI(9)),(PTXOPI,BSI(10)),(TEXOTI,BSI(11)),	0438 663
5(PSPID,BSO(9)),(PTPID,BSO(10)),(TXTID,BSO(11)),	0439 663
6(GRTMPI,BSI(2)),(GRTMPO,BSO(2))	0440 663
	0441 663
EQUIVALENCE(COFHLM,HTABI),(EXHPLM,HTABI(2)),(EXHRLM,	0442 663
1HTABI(3)),(COFHTB,HTABI(4)),(EXHPTB,HTABI(5)),(EXHRTB,	0443 663
2HTABI(6))	0444 663
EQUIVALENCE(DPTIN,DPARAM),(DTTIN,DPARAM(2)),(DTTEX,DPARAM(3)),	0445 663
1(DTWMAX,DPARAM(4)),(DPSEX,DPARAM(5)),(DPTEX,DPARAM(6)),(DW,DPARAM	0446 663
27)),(DQTOT,DPARAM(8)),(NOPTIN,KPARAM),	0447 663
3(NOTTIN,KPARAM(2)),(NOTTEX,KPARAM(3)),(NOTWMX,NTWMAX,NOTWA,	0448 663
4KPARAM(4)),(NOPSEX,KPARAM(5)),(NOPTEX,KPARAM(6)),(NOW,KPARAM(7)),	0449 663
5(NOQTOT,KPARAM(8))	0450 663

*	0451 663
*LIMITED USAGE	0452 663
DIMENSION AFFD(100),DHD(100),OLEND(100),XOL(100)	0453 663
EQUIVALENCE(AFFD,AFF(2)),(CLOSSI,CLOSS(2)),(CLSM DI,CLSMOD(2)),	0454 663
1(DHD,DH(2)),(DH,DOUTER,ELPM AJ,WIDTH),(AFF,DINNER,ELPM IN,	0455 663
2HEIGHT),(FMULTI,FMULT(2)),(HMULTI,HMULT(2)),(ROUND,KRSCON),	0456 663
3(RECTNG,KRSCON(2)),(ELLIPS,KRSCON(3)),(RINGS,KRSCON(4)),	0457 663
4(OLEND,LENGTH(2)),(NRINGD,NORING(2)),(NAFF,NAFL),(THICKD,	0458 663
5THICK(2)),(PTIN,PIN),(TTIN,TIN),(PTEX,PEX),(TEX,TTEX),	0459 663
6(CASE,KASE),(CASTEP,KASTEP),(DHD,DHG),(DH,DHG SUB),(AFF,	0460 663
7AFFSUB),(OLEND,OL),(LENGTH,OLSUB),(ACCMNO,PER),(NOSTGE,MN),	0461 663
8(HTABI(4),A1),(FTABI(3),B1),(FTABI(4),OM),(FMULTI,AKF),(HMULTI,	0462 663
9AKH),(CIN,C1),(CEX,C2),(PHISUM,A2),(PHIEX,Q),(NLEN,NOL)	0463 663
EQUIVALENCE(NDH,NDHG),(MAXMNO,OMAXD)	0464 663
*ALL MODIFIED OFF-DESIGN(ANP 443) INPUT VARIABLES	0465 663
* ARE IN DIP LIST, FUNCTIONALLY WHEREVER POSSIBLE	0466 663
*	0467 663
* * * MASTER GROUPING	0468 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	0469 663
1BG(5474)	0470 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	0471 663
COMMON BG	0472 663
* * * END OF MASTER GROUPING	0473 663
*END OF STORAGE MAP	0474 663
*	0475 663
*IS THIS A PARAMETRIC STUDY	0476 663
IF(MORCAS)90,90,80	0477 663
*IS THIS FIRST PARAMETRIC CASE	0478 663
80 IF(FSTPAR)1080,1080,90	0479 663
*EITHER NCN-PARAM OR FIRST PASS	0480 663
90 CONTINUE	0481 663
*TRANSFER FROM INPUT TO PERM TABLES	0482 663
CALL DSTRB1(BSI,11,BSO,0,0,KSIG)	0483 663
*	0484 663
*CHECK CROSS SECTION OPTIONS	0485 663
DO 110 ND=1,4	0486 663
ND=ND	0487 663
IF(KRSCON(ND))140,110,140	0488 663
110 CONTINUE	0489 663
*NO OPTION EXERCISED	0490 663
KRT=1	0491 663
115 CALL DSTRB1(DHD,NOSTGE,DHI,0,0,KSIG)	0492 663
120 CALL DSTRB1(DHI,NOSTGE,DHI,NDH,2,KSIG)	0493 663
GO TO(125,150),KRT	0494 663
125 CALL DSTRB1(AFFD,NOSTGE,AFFI,0,0,KSIG)	0495 663
130 CALL DSTRB1(AFFI,NOSTGE,AFFI,NAFL,2,KSIG)	0496 663
GO TO 225	0497 663
*CROSS SECTION OPTION-PROCESSING	0498 663
140 IF(ND-1)145,145,150	0499 663
*ROUND	0500 663
145 KRT=2	0501 663
GO TO 115	0502 663
*GENERAL	0503 663
150 DO 210 N=1,NOSTGE	0504 663
IF(ND-1)155,155,165	0505 663
*ROUND	0506 663
155 IF(DHI(N))210,210,160	0507 663

160 AFFI(N)=.7854*DHI(N)**2	0508 663
GO TO 210	0509 663
*GENERAL	0510 663
165 IF(DHD(N))170,170,167	0511 663
167 DHDLOC=DHD(N)	0512 663
*	0513 663
*BACKSPACING SECTION	0514 663
170 K1=0	0515 663
K2=0	0516 663
K3=0	0517 663
DO 190 K=1,N	0518 663
KD=N K+1	0519 663
IF(K1)172,172,176	0520 663
*GENERAL	0521 663
172 IF(AFFD(KD))176,176,174	0522 663
174 AFFLOC=AFFD(KD)	0523 663
K1=1	0524 663
*SPECIFIC	0525 663
176 IF(3 ND)178,190,190	0526 663
*CONCENTRIC	0527 663
178 IF(K2)180,180,184	0528 663
*THICKNESS	0529 663
180 IF(THICKD(KD))184,184,182	0530 663
182 THKLOC=THICKD(KD)	0531 663
K2=1	0532 663
184 IF(K3)186,186,190	0533 663
*NO OF RINGS	0534 663
186 IF(NRINGD(KD))190,190,188	0535 663
188 FRINGS=FLOATF(NRINGD(KD))	0536 663
K3=1	0537 663
190 CONTINUE	0538 663
*BACKSPACING FINISHED	0539 663
*	0540 663
*SPECIFIC	0541 663
IF(ND-3)195,200,205	0542 663
*RECTANGULAR	0543 663
195 AFFI(N)=DHDLOC*AFFLOC	0544 663
DHI(N)=2.*AFFI(N)/(DHDLOC+AFFLOC)	0545 663
GO TO 210	0546 663
*ELLIPTICAL	0547 663
200 AFFI(N)=.7854*DHDLOC*AFFLOC	0548 663
DHI(N)=1.80063*AFFI(N)/SQRTF(DHDLOC**2+AFFLOC**2)	0549 663
GO TO 210	0550 663
*CONCENTRIC RINGS	0551 663
205 DHI(N)=((DHDLOC-AFFLOC)/(FRINGS-1.))-2.*THKLOC	0552 663
AFFI(N)=.3927*FRINGS*DHI(N)*(DHDLOC+AFFLOC)	0553 663
210 CONTINUE	0554 663
225 CONTINUE	0555 663
*FINISHED WITH CROSS SECTION OPTIONS	0556 663
*	0557 663
*X/L STAGE LENGTH OPTION	0558 663
250 IF(TOTLEN)251,255,251	0559 663
*X/L STAGE LENGTHS LENGTHS LOADED	0560 663
251 DO 254 N=1,NOSTGE	0561 663
IF(N 1)252,252,253	0562 663
252 OLENI(N)=XOL(N)*TOTLEN	0563 663
GO TO 254	0564 663

253	OLENI(N)=(XOL(N)-XOL(N-1))*TOTLND	0565	663
254	CONTINUE	0566	663
	TOTLND=TOTLND	0567	663
	CALL DSTRB1(XOL,NOSTGE,XOLD,0,0,KSIG)	0568	663
	GO TO 258	0569	663
*STAGE LENGTHS LOADED		0570	663
255	CALL DSTRB1(OLEND,NOSTGE,OLENI,0,0,KSIG)	0571	663
	CALL DSTRB1(OLENI,NOSTGE,OLENI,NLEN,2,KSIG)	0572	663
	TOTLND=0.	0573	663
	DO 256 N=1,NOSTGE	0574	663
256	TOTLND=TOTLND+OLENI(N)	0575	663
	SUMLEN=0.	0576	663
	DO 257 N=1,NOSTGE	0577	663
	SUMLEN=SUMLEN+OLENI(N)	0578	663
	XOLD(N)=SUMLEN/TOTLND	0579	663
257	CONTINUE	0580	663
*STAGE LENGTH PROCESSING FINISHED		0581	663
258	CONTINUE	0582	663
*INTERSTAGE LOSS COEFFICIENTS		0583	663
	CALL DSTRB1(CLSMDI,NOSTGE,CLSMDI,NCLSM,2,KSIG)	0584	663
	CALL DSTRB1(CLOSSI,NOSTGE,CLOSSI,NCLOSS,2,KSIG)	0585	663
*CHECK PRES RATIO INPUT		0586	663
	IF(PIN)266,266,260	0587	663
260	IF(PEX)266,261,263	0588	663
261	IF(PTXOPI)266,263,262	0589	663
262	PEXD=PIN*PTXOPI	0590	663
263	IF(PSEX)266,264,266	0591	663
264	IF(PSXOPI)266,266,265	0592	663
265	PSEXD=PIN*PSXOPI	0593	663
266	CONTINUE	0594	663
*CHECK NEED FOR UNIT CHANGES		0595	663
	IF(FTIN)268,310,268	0596	663
*CHECK FOR LENGTH UNIT CHANGE DELAY		0597	663
268	IF(NOINPT)270,269,270	0598	663
269	IF(PARPRT)270,274,270	0599	663
270	DO 272 N=1,NOSTGE	0600	663
	DHI(N)=DHI(N)*12.	0601	663
	OLENI(N)=OLENI(N)*12.	0602	663
	AFFI(N)=AFFI(N)*144.	0603	663
272	CONTINUE	0604	663
	TOTLND=TOTLND*12.	0605	663
274	PEXD=PEXD/144.	0606	663
	PIND=PIND/144.	0607	663
	PSEXD=PSEXD/144.	0608	663
310	IF(RNKIN)400,320,400	0609	663
320	CALL CONTMP(GRTMPI,3,GRTMPO,1)	0610	663
400	CONTINUE	0611	663
*CHECK TEMP RATIO INPUT		0612	663
	IF(TIN)440,440,425	0613	663
425	IF(TEX)440,430,440	0614	663
430	IF(TEXOTI)440,440,435	0615	663
435	TEXD=TIND*TEXOTI	0616	663
*CHECK FOR QBAR INPUT		0617	663
440	IF(QOQBAR)450,470,450	0618	663
450	IF(QBAR)460,470,460	0619	663
460	QTOTD=QOQBAR*QBAR	0620	663
	QIPI=QTOTD	0621	663

470 CONTINUE	0622 663
*AUTOMATIC DISTRIBUTION OF STAGE LENGTH	0623 663
IF(OLEND(1))500,580,500	0624 663
*ARE DOWNSTREAM STAGE LENGTHS ZERO	0625 663
500 DO 510 N=2,NOSTGE	0626 663
IF(CLEND(N))510,510,580	0627 663
510 CONTINUE	0628 663
*IS ANY DISTRIBUTION SUPPLIED	0629 663
IF(NLEN(1))520,520,580	0630 663
520 DO 570 N=2,NOSTGE	0631 663
*IS AN EXIT LOSS COEFFICIENT PROVIDED	0632 663
530 IF(CLOSSI(N))570,540,570	0633 663
*CAN LOSS COEFFICIENT BE CALCULATED	0634 663
540 IF(AUTOLS)550,560,550	0635 663
*IS THERE AN AREA CHANGE	0636 663
550 IF(AFFI(N)-AFFI(N-1))570,560,570	0637 663
*SUPPLY STAGE LENGTH	0638 663
560 OLENI(N)=OLEND(1)	0639 663
570 CONTINUE	0640 663
580 CONTINUE	0641 663
*PROCESS POWER PROFILE	0642 663
KPOW=0	0643 663
DO 1030 N=1,NOSTGE	0644 663
IF(P0(N))990,990,1060	0645 663
990 IF(P1(N))1000,1000,1060	0646 663
1000 IF(P2(N))1010,1010,1060	0647 663
1010 IF(PHISUM(N))1030,1030,1020	0648 663
1020 KPOW=1	0649 663
1030 CONTINUE	0650 663
GO TO 1080	0651 663
*INTEGRATE TABULAR PROFILE	0652 663
1060 CALL POWER3(PHIEX,PHISUM,NOSTGE,OLENI,P0,P1,P2)	0653 663
KPOW=1	0654 663
1080 CONTINUE	0655 663
*PROCESSING FINISHED	0656 663
RETURN	0657 663
END(0,1,0)	0658 663
* * * * *	0659 663
DPFRLT A SR TO CALCULATE PRESS DROP FOR LALMINAR OR TURBULENT FLOW	0660 663
WITH OR WITHOUT ENTRANCE LENGTH EFFECTS	0661 663
GFP 663 GENERAL FLOW PASSAGE	0662 663
S C SKIRVIN	0663 663
USAGE - CALL DPFRLT(IDENTIFICATION WANTED(=1 IF YES))	0664 663
	0665 663
SUBROUTINE DPFRLT(IDENT)	0666 663
	0667 663
BEGIN STORAGE MAP	0668 663
GENERAL USAGE	0669 663
DIMENSION	0670 663
1AFFI (100),BSI (11),BSO (11),CLOSSI(100),CLSGEN(100),	0671 663
2CLSMPI(100),DHI (100),DPARAM(8),DPARMI(8),FMULTI(100),	0672 663
3FTABI (8),FPARMI(8),HTABI (6),HMULTI(100),KRSCON(4),	0673 663
4KPARAM(8),KPARMR(8),NDH (100),NAFL (100),NLEN (100),	0674 663
5NCLOSS(100),NCLSMPI(100),NRINGD(100),NHMULT(100),NFMULT(100),	0675 663
6OLENI (100),PHISUM(100),PHIEX (100),P0 (100),P1 (100),	0676 663
7P2 (100),THICKD(100),TEXI (100),XOLD (100),BHIGH (12),	0677 663
8HEDDUM(12),GMASS (100),TW (100),REYNO (100),FRIC (100),	0678 663

9CONVEC(100),DPINT(100),OMEXI(100),PRTGAS(9)	0679 663
DIMENSION PSEXI(100),PDYEXI(100),PEXI(100)	0680 663
*3G0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP	0681 663
EQUIVALENCE	0682 663
1(AD ,BG0(1)),(ACCMNO,BG0(2)),(ACCPRS,BG0(3)),	0683 663
2(ACCTMP,BG0(4)),(ALLRUN,BG0(5)),(AUTOLS,BG0(6)),	0684 663
3(BD ,BG0(7)),(BLANKS,BG0(8)),(BETA1 ,BG0(9)),	0685 663
4(BETA2 ,BG0(10)),(CIN ,BG0(11)),(CEX ,BG0(12)),	0686 663
5(DEAD ,BG0(13)),(DELH ,BG0(14)),(DERIV ,BG0(15)),	0687 663
6(ENTRN ,BG0(16)),(ENTRNC,BG0(17)),(FD ,BG0(18)),	0688 663
7(FTIN ,BG0(19)),(FTOUT ,BG0(20)),(FSTPAR,BG0(21)),	0689 663
8(GOAL ,BG0(22)),(GAS ,BG0(23)),(HIN ,BG0(24)),	0690 663
9(ITRY ,BG0(25)),(KTRCRD,BG0(26)),(KALCNO,BG0(27)),	0691 663
EQUIVALENCE	0692 663
1(KTCHAD,BG0(28)),(KTWADJ,BG0(29)),(KTCHTO,BG0(30)),	0693 663
2(KPOW ,BG0(31)),(KOPT ,BG0(32)),(KOSCIL,BG0(33)),	0694 663
3(KCHOKE,BG0(34)),(KASE ,BG0(35)),(KASTEP,BG0(36)),	0695 663
4(LOC ,BG0(37)),(LIMCHK,BG0(38)),(LMCHTO,BG0(39)),	0696 663
5(LIMTRY,BG0(40)),(MORCAS,BG0(41)),(NSKPPR,BG0(42)),	0697 663
6(NSKPHT,BG0(43)),(NT ,BG0(44)),(NHOT ,BG0(45)),	0698 663
7(NOPRT ,BG0(46)),(NOSTGE,BG0(47)),(PARPRT,BG0(48)),	0699 663
8(PRTSUM,BG0(49)),(RNKIN ,BG0(50)),(RNKOUT,BG0(51)),	0700 663
9(SVACMN,BG0(52)),(SVACPR,BG0(53)),(TOTLND,BG0(54)),	0701 663
EQUIVALENCE	0702 663
1(TRY0 ,BG0(55)),(TRY1 ,BG0(56)),(TRY2 ,BG0(57)),	0703 663
2(TRY3 ,BG0(58)),(TEST1 ,BG0(59)),(TOTLEN,BG0(60)),	0704 663
3(WHI ,BG0(61)),(WLO ,BG0(62)),(YIELD0,BG0(63)),	0705 663
4(YIELD1,BG0(64)),(YIELD2,BG0(65)),(NOINPT,BG0(66)),	0706 663
5(LIMPRS,BG0(67)),(PRTALL,BG0(68)),(OMAXD ,BG0(69)),	0707 663
6(OMAX,BG0(70))),(OMAX1,BG0(71))),(KOPTH,BG0(72)),	0708 663
7(DMCONV,BG0(75))),(KDI,BG0(76))),(KDD,BG0(77))),(TRYMAX,BG0(78))),(MAXTMP,BG0(79))),(LMBULK,BG0(80))),(TBBULK,BG0(81)),	0709 663
878))),(KCHK1,BG0(1))),(KCHK2,BG0(7))),(KCHK3,BG0(18))),(KGAS,BG0(82))	0710 663
9(KCHK1,BG0(1))),(KCHK2,BG0(7))),(KCHK3,BG0(18))),(KGAS,BG0(82))	0711 663
EQUIVALENCE(PDYIN,BG0(73))),(PDYEX,BG0(74))),(OMINLT,BG0(83)),	0712 663
1(OMEXIT,BG0(84))),(DPIN,BG0(85))),(DPEX,BG0(86))	0713 663
2,(TRANSF,BG0(87))),(TRANHL,BG0(88))),(TRANHU,BG0(89))	0714 663
3,(NEWSET,BG0(90))),(KTPAR,BG0(91))),(KTOTPR,BG0(92))),(QBAR,BG0(93)),	0715 663
4(QQBAR,BG0(94))),(NOGEOM,BG0(95))	0716 663
EQUIVALENCE	0717 663
1(AFFD ,BG1(2)),(AFFI ,BG1(102)),(BSI ,BG1(202)),	0718 663
2(BSO ,BG1(213)),(BHIGH ,BG1(224)),(CLOSSI,BG1(237)),	0719 663
3(CLSGEN,BG1(337)),(CLSMDI,BG1(438)),(DHD ,BG1(539)),	0720 663
4(DHI ,BG1(639)),(DPARAM,BG1(739)),(DPARMI,BG1(747)),	0721 663
5(FTABI ,BG1(755)),(FPARMI,BG1(759)),(FMULTI,BG1(768)),	0722 663
6(GMASS ,BG1(868)),(HTABI ,BG1(968)),(HEDDUM,BG1(974)),	0723 663
7(HMULTI,BG1(987)),(KPARAM,BG1(1087)),(KPARMR,BG1(1095)),	0724 663
8(KRSCON,BG1(1103)),(NDH ,BG1(1107)),(NAFL ,BG1(1207)),	0725 663
9(NLEN ,BG1(1307)),(NCLOSS,BG1(1407)),(NCLSMD,BG1(1507)),	0726 663
EQUIVALENCE	0727 663
1(NHMULT,BG1(1607)),(NFMULT,BG1(1707)),(OLEND ,BG1(1808)),	0728 663
2(OLENI ,BG1(1908)),(PHISUM,BG1(2008)),(PHIEX ,BG1(2108)),	0729 663
3(P0 ,BG1(2208)),(P1 ,BG1(2308)),(P2 ,BG1(2408)),	0730 663
4(TEXI ,BG1(2508)),(TW ,BG1(2608)),(XOLD ,BG1(2708)),	0731 663
5(XOL ,BG1(2808)),(REYNO ,BG1(2908)),(FRIC ,BG1(3008)),	0732 663
6(CONVEC,BG1(3108))),(DPINT,BG1(3208))),(OMEXI,BG1(3308))	0733 663
7,(PRTGAS,BG1(3408))),(PSEXT,BG1(3417))),(PDYEXI,BG1(3517))	0734 663

*OPEN AT 3617, KEEP OPEN UNTIL 3700	0735 663
DIMENSION KONOPT(2,10),KONPAR(4,13),SAVTAB(13,100),KSVTAB(13,100)	0736 663
EQUIVALENCE(KONOPT,KUP,BG2),(KONPAR,BG2(21)),	0737 663
1(SAVTAB,KSVTAB,BG2(73))	0738 663
*OPEN 1373	0739 663
EQUIVALENCE(THICKD,BG3(2)),(NRINGD,BG3(103)),(PEXI,BG3(203))	0740 663
*	0741 663
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2)),(COFFTB,	0742 663
1FTABI(3)),(EXPFTB,FTABI(4))	0743 663
*	0744 663
*BASIC OPTIONAL VARIABLES	0745 663
DIMENSION GRTMPI(3),GRTMPO(3)	0746 663
EQUIVALENCE(PIN,BSI),(TIN,BSI(2)),(TEX,BSI(3)),(TWMAX,	0747 663
1BSI(4)),(PSEX,BSI(5)),(PEX,BSI(6)),(W,BSI(7)),(QTOT,	0748 663
2BSI(8)),(PIND,BSO),(TIND,BSO(2)),(TEXD,BSO(3)),(TWMAXD,	0749 663
3BSO(4)),(PSEXD,BSO(5)),(PEXD,BSO(6)),(WD,BSO(7)),(QTOTD,	0750 663
4BSO(8)),(PSXOPI,BSI(9)),(PTXOPI,BSI(10)),(TEXOTI,BSI(11)),	0751 663
5(PSPID,BSO(9)),(PTPID,BSO(10)),(TXTID,BSO(11)),	0752 663
6(GRTMPI,BSI(2)),(GRTMPO,BSO(2))	0753 663
*	0754 663
EQUIVALENCE(COFHLM,HTABI),(EXHPLM,HTABI(2)),(EXHRLM,	0755 663
1HTABI(3)),(COFHTB,HTABI(4)),(EXHPTB,HTABI(5)),(EXHRTB,	0756 663
2HTABI(6))	0757 663
EQUIVALENCE(DPTIN,DPARAM),(DTTIN,DPARAM(2)),(DTTEX,DPARAM(3)),	0758 663
1(DTWMAX,DPARAM(4)),(DPSEX,DPARAM(5)),(DPTTEX,DPARAM(6)),(DW,DPARAM(	0759 663
27)),(DQTOT,DPARAM(8)),(NOPTIN,KPARAM),	0760 663
3(NOTTIN,KPARAM(2)),(NOTTEX,KPARAM(3)),(NOTWMX,NTWMAX,NOTWA,	0761 663
4KPARAM(4)),(NOPSEX,KPARAM(5)),(NOPTTEX,KPARAM(6)),(NOW,KPARAM(7)),	0762 663
5(NOQTOT,KPARAM(8))	0763 663
*	0764 663
* * * MASTER GROUPING	0765 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	0766 663
1BG(5474)	0767 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	0768 663
COMMON BG	0769 663
* * * END OF MASTER GROUPING	0770 663
*	0771 663
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2)),(COFFTB,FTABI(3)),	0772 663
1(EXPFTB,FTABI(4)),(ND,NOSTGE),(G,GMASS),(REAVG,REYNO),	0773 663
2(OMEX,OMEXI)	0774 663
DIMENSION G(100),REAVG(100),OMEX(100)	0775 663
*END OF STORAGE MAP	0776 663
*	0777 663
ND=NOSTGE	0778 663
*IS IDENTIFICATION REQUESTED	0779 663
IF(IDENT)95,95,90	0780 663
90 PRINT 32000	0781 663
32000 FORMAT	0782 663
SPACE 2	0783 663
* * THE PRES DROP SR (DPFRLT) IS BASED ON THE OFF DESIGN * *	0784 663
* * ANALYSIS AND REQUIRES UPSTREAM PRESSURES * *	0785 663
END OF FORMAT	0786 663
GO TO 96	0787 663
*	0788 663
95 CONTINUE	0789 663
*INITIALIZATION	0790 663
	0791 663

SUMLEN=0.	0792 663
OMAX=0.	0793 663
*STAGE BY STAGE	0794 663
96 DO 820 N=1,ND	0795 663
KTPRS=1	0796 663
*WAS IDENTIFICATION REQUESTED	0797 663
IF(IDENT)98,98,200	0798 663
*NORMAL SEQUENCING	0799 663
*FIRST STAGE ONLY	0800 663
98 IF(N 1)100,100,120	0801 663
100 OMIN=AMACH(.1,G(1),PIND,TIND,ACCMNO,GAS)	0802 663
OMINLT=OMIN	0803 663
OMAX=MAX1F(OMAX,OMIN)	0804 663
IF(.9-OMIN)10000,10000,102	0805 663
102 PDYIN=DYPRS(G(1),PIND,TIND,OMIN,GAS)	0806 663
*CHECK ENTRANCE LOSS	0807 663
IF(CIN)106,104,106	0808 663
104 PINI=PIND	0809 663
DPIN=0.	0810 663
GO TO 108	0811 663
106 DPIN=CIN*PDYIN	0812 663
PINI=PIND-DPIN	0813 663
OMIN=AMACH(OMIN,G(1),PINI,TIND,ACCMNO,GAS)	0814 663
OMAX=MAX1F(OMAX,OMIN)	0815 663
IF(.9-OMIN)10000,10000,108	0816 663
108 TINI=TIND	0817 663
GO TO 130	0818 663
*SUBSEQUENT STAGES ONLY	0819 663
120 OMIN=AMACH(OMEXI(N),G(N),PINI,TINI,ACCMNO,GAS)	0820 663
OMAX=MAX1F(OMAX,OMIN)	0821 663
IF(.9-OMIN)10000,10000,130	0822 663
*ALL STAGES	0823 663
130 CONTINUE	0824 663
IF(OLENI(N))132,132,133	0825 663
132 PEXI(N)=PINI	0826 663
FRIC(N)=0.0	0827 663
GO TO 740	0828 663
133 IF(DHI(N))134,134,136	0829 663
134 REAVG(N)=0.	0830 663
GO TO 132	0831 663
136 OMEX1=1.05*OMIN	0832 663
IF(.9-OMEX1)140,140,150	0833 663
140 OMEX1=.899	0834 663
150 OMAVG=(OMEX1+OMIN)/2.	0835 663
TAVG=(TEXI(N)+TINI)/2.	0836 663
REAVG(N)=G(N)*DHI(N)*12./VISC(TAVG,GAS)	0837 663
SUMLEN=SUMLEN+OLENI(N)	0838 663
*OBTAIN FRICTION FACTOR	0839 663
200 FRIC(N)=FRCFAC(REAVG(N),DHI(N),SUMLEN,COFFLM,EXPFLM,	0840 663
1COFFTB,EXPFTB,BETA1,BETA2,ENTRNC,IDENT)	0841 663
2*FMULTI(N)	0842 663
*WAS IDENTIFICATION REQUESTED	0843 663
IF(IDENT)210,210,860	0844 663
*NORMAL CONTINUATION	0845 663
210 CONTINUE	0846 663
PBARN=PINI	0847 663
COFMAÇ=-(GAM(TAVG,GAS)/2.)*	0848 663

1 (LOGF (TEXI (N) / TINI) + (4. * FRIC (N) * OLENI (N) / DHI (N)))	0849 663
680 PEXI (N) = PINI * EXPF (COFMAC * OMAVG ** 2)	0850 663
OMEX (N) = AMACH (OMEX1, G (N), PEXI (N), TEXI (N), ACCMNO, GAS)	0851 663
OMAX = MAX1F (OMAX, OMEX (N))	0852 663
IF (.9 - OMEX (N)) 10000, 10000, 700	0853 663
10000 KCHOKE = N	0854 663
GO TO 890	0855 663
700 IF (ABSF ((PEXI (N) - PBARN) / PEXI (N)) - ACCPRS) 740, 740, 710	0856 663
*HAS COUNTER LIMIT BEEN EXCEEDED	0857 663
710 IF (LIMPRS - KTPRS) 720, 730, 730	0858 663
720 CALL NETERR (180, N)	0859 663
SENSE LIGHT 2	0860 663
GO TO 890	0861 663
730 KTPRS = KTPRS + 1	0862 663
OMAVG = (OMIN + OMEX (N)) / 2.	0863 663
OMEX1 = OMEX (N)	0864 663
PBARN = PEXI (N)	0865 663
GO TO 680	0866 663
*CALC EXIT DYNAMIC PRESSURE	0867 663
740 PDYEXI (N) = DYPRS (G (N), PEXI (N), TEXI (N), OMEX (N), GAS)	0868 663
*IS THIS THE LAST STAGE	0869 663
IF (ND - N) 780, 780, 750	0870 663
*IS AUTO LOSS CALC WANTED	0871 663
750 IF (AUTOLS) 780, 780, 755	0872 663
*DOES AREA CHANGE	0873 663
755 IF (AFFI (N) / AFFI (N + 1) - 1.) 757, 780, 756	0874 663
756 KLOSS = 1	0875 663
GO TO 760	0876 663
757 KLOSS = 3	0877 663
*IS AUTO LOSS MODIFIER DIFFERENT THAN ZERO	0878 663
760 IF (CLSM DI (N)) 765, 780, 765	0879 663
*CALC AUTO LOSS COEFF	0880 663
765 CALL LOSS (AFFI (N), AFFI (N - 1), KLOSS, OMEX (N), DUM1, DUM2,	0881 663
1DUM3, CLSGEN (N))	0882 663
DPINT (N) = CLSGEN (N) * CLSM DI (N) * PDYEXI (N)	0883 663
GO TO 810	0884 663
*REGULAR INTERSTAGE LOSS CALC	0885 663
780 IF (CLOSSI (N)) 790, 800, 790	0886 663
790 DPINT (N) = CLOSSI (N) * PDYEXI (N)	0887 663
GO TO 810	0888 663
800 DPINT (N) = 0.	0889 663
810 PINI = PEXI (N) - DPINT (N)	0890 663
OMIN = OMEX (N)	0891 663
TINI = TEXI (N)	0892 663
820 CONTINUE	0893 663
*STAGE-BY-STAGE CALCULATIONS FINISHED	0894 663
*SET EXIT MACH NO	0895 663
IF (DPINT (ND)) 840, 830, 840	0896 663
830 OMEXIT = OMIN	0897 663
PDYEX = PDYEXI (ND)	0898 663
GO TO 850	0899 663
840 OMEXIT = AMACH (OMIN, G (ND), PINI, TINI, ACCMNO, GAS)	0900 663
PDYEX = DYPRS (G (ND), PINI, TINI, OMEXIT, GAS)	0901 663
*EXIT STATIC PRESSURE	0902 663
850 PSEXDP = PSTAT (PINI, TINI, OMEXIT, GAS)	0903 663
*EXIT LOSS CALC	0904 663
IF (CFX) 870, 860, 870	0905 663

860 DPEX=0.	0906 663
GO TO 880	0907 663
870 DPEX=CEX*PDYEX	0908 663
880 PEXD=PINI-DPEX	0909 663
*SR FINISHED	0910 663
890 CONTINUE	0911 663
RETURN	0912 663
END(0,0,0)	0913 663
* * * * *	0914 663
CFRCFAC00A FUNCTION TO EVALUATE FRICTION FACTORS	0915 663
* FOR GFP(ANP 663)	0916 663
*USEAGE - FRCFAC(REY NO, HYDR DIAM, DISTANCE FROM ENTRANCE,	0917 663
* COEFF LAM, EXP LAM, COEFF TURB, EXP TURB, LAM ENTRANCE	0918 663
* COEFF, TURB ENTRANCE COEFF, ENTRANCE EFFECT WANTED	0919 663
* (=1 IF YES), IDENTIFICATION WANTED(=1 IF YES))	0920 663
FUNCTION FRCFAC(REYNO,DH,SUMLN,COFFLM,EXPFLM,	0921 663
1COFFTB,EXPFTB,BETA1,BETA2,ENTRN,IDENT)	0922 663
*BEGIN STORAGE MAP	0923 663
* * * MASTER GROUPING	0924 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	0925 663
1BG(5474)	0926 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	0927 663
COMMON BG	0928 663
* * * END OF MASTER GROUPING	0929 663
EQUIVALENCE(TRANSF,BG0(87)),(TRANHL,BG0(89)),(TRANHU,BG0(90))	0930 663
*END OF STORAGE MAP	0931 663
*IS IDENTIFICATION REQUESTED	0932 663
IF(IDENT)120,120,100	0933 663
100 PRINT 32000	0934 663
32000 FORMAT	0935 663
SPACE 2	0936 663
* * THE LENGTH-DEPENDENT FRICTION FACTOR * *	0937 663
* * IS CALCULATED FROM * *	0938 663
* F.F.=F.F.(INF)*(1 BETA1*N(RE)*(DH/LEN)) (N(RE) LESS OR = 2300)	0939 663
* F.F.=F.F.(INF)*(1 BETA2*(DH/LEN)) (N(RE) MORE THAN 2300)	0940 663
END OF FORMAT	0941 663
GO TO 190	0942 663
*TRANSITION TEST	0943 663
120 IF(REYNO)122,122,124	0944 663
122 FRCFAC=0.	0945 663
GO TO 190	0946 663
124 IF(REYNO-TRANSF)130,130,160	0947 663
*LAMINAR	0948 663
130 FRCFAC=COFFLM*REYNO**EXPFLM	0949 663
*IS ENTRANCE LENGTH EFFECT REQUESTED	0950 663
IF(ENTRN)190,190,140	0951 663
*IS LENGTH FACTOR PRESENT	0952 663
140 IF(BETA1)150,190,150	0953 663
*CALC ENTRANCE EFFECT	0954 663
150 FRCFAC=FRCFAC*(1.+(BETA1*REYNO*DH/SUMLN))	0955 663
GO TO 190	0956 663
*TURBULENT	0957 663
160 FRCFAC=COFFTB*REYNO**EXPFTB	0958 663
*IS ENTRANCE LENGTH EFFECT REQUESTED	0959 663
IF(ENTRN)190,190,170	0960 663
*IS LENGTH FACTOR PRESENT	0961 663
170 IF(BETA2)180,190,180	0962 663

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*CALC ENTRN EFFECT                                0963 663
  180 FRCFAC=FRCFAC*(1.+BETA2*DH/SUMLEN)          0964 663
*FINISHED                                          0965 663
  190 CONTINUE                                     0966 663
    RETURN                                         0967 663
    END(0,1,0)                                    0968 663
* * * * *                                          0969 663
*INITAL SR TO PERFORM PRE-LOAD INITIALIZATION FOR 0970 663
*GFP 663 GENERAL FLOW PASSAGE                    0971 663
*  S C SKIRVIN                                    0972 663
*                                                  0973 663
    SUBROUTINE INITAL                             0974 663
*                                                  0975 663
*BEGIN STORAGE MAP                               0976 663
*GENERAL USEAGE                                   0977 663
  DIMENSION                                       0978 663
  1AFFI (100 ),BSI (11 ),BSO (11 ),CLOSSI(100 ),CLSGEN(100 ), 0979 663
  2CLSM DI(100 ),DHI (100 ),DPARAM(8 ),DPARMI(8 ),FMULTI(100 ), 0980 663
  3FTABI (8 ),FPARMI(8 ),HTABI (6 ),HMULTI(100 ),KRSCON(4 ), 0981 663
  4KPARAM(8 ),KPARMR(8 ),NDH (100 ),NAFL (100 ),NLEN (100 ), 0982 663
  5NCLOSS(100 ),NCLSM D(100 ),NRINGD(100 ),NHMULT(100 ),NFMULT(100 ), 0983 663
  6OLENI (100 ),PHISUM(100 ),PHIEX (100 ),PO (100 ),P1 (100 ), 0984 663
  7P2 (100 ),THICKD(100 ),TEXI (100 ),XOLD (100 ),BHIGH (12 ), 0985 663
  8HEDDUM(12 ),GMASS (100 ),TW (100 ),REYNO (100 ),FRIC (100 ), 0986 663
  9CONVEC(100 ),DPINT(100 ),OMEXI(100 ),PRTGAS(9) 0987 663
  DIMENSION PSEXI(100 ),PDYEXI(100 ),PEXI(100) 0988 663
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP 0989 663
  EQUIVALENCE                                     0990 663
  1(AD ,BG0(1 ),(ACCMNO,BG0(2 ),(ACCPRS,BG0(3 ), 0991 663
  2(ACCTMP,BG0(4 ),(ALLRUN,BG0(5 ),(AUTOLS,BG0(6 ), 0992 663
  3(BD ,BG0(7 ),(BLANKS,BG0(8 ),(BETA1 ,BG0(9 ), 0993 663
  4(BETA2 ,BG0(10 ),(CIN ,BG0(11 ),(CEX ,BG0(12 ), 0994 663
  5(DEAD ,BG0(13 ),(DELH ,BG0(14 ),(DERIV ,BG0(15 ), 0995 663
  6(ENTRN ,BG0(16 ),(ENTRNC,BG0(17 ),(FD ,BG0(18 ), 0996 663
  7(FTIN ,BG0(19 ),(FTOUT ,BG0(20 ),(FSTPAR,BG0(21 ), 0997 663
  8(GOAL ,BG0(22 ),(GAS ,BG0(23 ),(HIN ,BG0(24 ), 0998 663
  9(ITRY ,BG0(25 ),(KTRCRD,BG0(26 ),(KALCNO,BG0(27 )) 0999 663
  EQUIVALENCE                                     1000 663
  1(KTCHAD,BG0(28 ),(KTWADJ,BG0(29 ),(KTCHTO,BG0(30 ), 1001 663
  2(KPOW ,BG0(31 ),(KOPT ,BG0(32 ),(KOSCIL,BG0(33 ), 1002 663
  3(KCHOKE,BG0(34 ),(KASE ,BG0(35 ),(KASTEP,BG0(36 ), 1003 663
  4(LOC ,BG0(37 ),(LIMCHK,BG0(38 ),(LMCHTO,BG0(39 ), 1004 663
  5(LIMTRY,BG0(40 ),(MORCAS,BG0(41 ),(NSKPPR,BG0(42 ), 1005 663
  6(NSKPHT,BG0(43 ),(NT ,BG0(44 ),(NHOT ,BG0(45 ), 1006 663
  7(NOPRT ,BG0(46 ),(NOSTGE,BG0(47 ),(PARPRT,BG0(48 ), 1007 663
  8(PRTSUM,BG0(49 ),(RNKIN ,BG0(50 ),(RNKOUT,BG0(51 ), 1008 663
  9(SVACMN,BG0(52 ),(SVACPR,BG0(53 ),(TOTLND,BG0(54 )) 1009 663
  EQUIVALENCE                                     1010 663
  1(TRY0 ,BG0(55 ),(TRY1 ,BG0(56 ),(TRY2 ,BG0(57 ), 1011 663
  2(TRY3 ,BG0(58 ),(TEST1 ,BG0(59 ),(TOTLEN,BG0(60 ), 1012 663
  3(WHI ,BG0(61 ),(WLO ,BG0(62 ),(YIELD0,BG0(63 ), 1013 663
  4(YIELD1,BG0(64 ),(YIELD2,BG0(65 ),(NOINPT,BG0(66 ), 1014 663
  5(LIMPRS,BG0(67 ),(PRTALL,BG0(68 ),(OMAXD ,BG0(69 )) 1015 663
  6(OMAX,BG0(70)),(OMAX1,BG0(71)),(KOPTH,BG0(72)), 1016 663
  7 (DMCONV,BG0(75)),(KDI,BG0(76)),(KDD,BG0(77)),(TRYMAX,BG0( 1017 663
  878)),(MAXTMP,BG0(79)),(LMBULK,BG0(80)),(TBBULK,BG0(81)), 1018 663
  9(KCHK1,BG0(1)),(KCHK2,BG0(7)),(KCHK3,BG0(18)),(KGAS,BG0(82)) 1019 663

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EQUIVALENCE(PDYIN,BG0(73)),(PDYEX,BG0(74)),(OMINLT,BG0(83)),	1020 66
1(OMEXIT,BG0(84)),(DPIN,BG0(85)),(DPEX,BG0(86))	1021 66
2,(TRANSF,BG0(87)),(TRANHL,BG0(88)),(TRANHU,BG0(89))	1022 66
3,(KTPAR,BG0(91)),(KTOTPR,BG0(92)),(QBAR,BG0(93)),	1023 66
4(QOQBAR,BG0(94)),(NOGEOM,BG0(95))	1024 66
EQUIVALENCE	1025 66
1(AFFD ,BG1(2)),(AFFI ,BG1(102)),(BSI ,BG1(202)),	1026 66
2(BSO ,BG1(213)),(BHIGH ,BG1(224)),(CLOSSI,BG1(237)),	1027 66
3(CLSGEN,BG1(337)),(CLSMDI,BG1(438)),(DHD ,BG1(539)),	1028 66
4(DHI ,BG1(639)),(DPARAM,BG1(739)),(DPARMI,BG1(747)),	1029 66
5(FTABI ,BG1(755)),(FPARAMI,BG1(759)),(FMULTI,BG1(768)),	1030 66
6(GMASS ,BG1(868)),(HTABI ,BG1(968)),(HEDDUM,BG1(974)),	1031 66
7(HMULTI,BG1(987)),(KPARAM,BG1(1087)),(KPARAMR,BG1(1095)),	1032 66
8(KRSCON,BG1(1103)),(NDH ,BG1(1107)),(NAFL ,BG1(1207)),	1033 66
9(NLEN ,BG1(1307)),(NCLOSS,BG1(1407)),(NCLSMD,BG1(1507))	1034 66
EQUIVALENCE	1035 66
1(NHMULT,BG1(1607)),(NFMULT,BG1(1707)),(OLEND ,BG1(1808)),	1036 66
2(OLENI ,BG1(1908)),(PHISUM,BG1(2008)),(PHIEX ,BG1(2108)),	1037 66
3(P0 ,BG1(2208)),(P1 ,BG1(2308)),(P2 ,BG1(2408)),	1038 66
4(TEXI ,BG1(2508)),(TW ,BG1(2608)),(XOLD ,BG1(2708)),	1039 66
5(XOL ,BG1(2808)),(REYNO ,BG1(2908)),(FRIC ,BG1(3008)),	1040 66
6(CONVEC,BG1(3108)),(DPINT,BG1(3208)),(OMEXI,BG1(3308))	1041 66
7,(PRTGAS,BG1(3408)),(PSEXI,BG1(3417)),(PDYEXI,BG1(3517))	1042 66
*OPEN AT 3617, KEEP OPEN UNTIL 3700	1043 66
DIMENSION KNOPT(2,10),KONPAR(4,13),SAVTAB(13,100),KSVTAB(13,100)	1044 66
EQUIVALENCE(KNOPT,KUP,BG2),(KONPAR,BG2(21)),	1045 66
1(SAVTAB,KSVTAB,BG2(73))	1046 66
*OPEN 1373	1047 66
EQUIVALENCE(THICKD,BG3(2)),(NRINGD,BG3(103)),(PEXI,BG3(203))	1048 66
*	1049 66
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2)),(COFFTB,	1050 66
1FTABI(3)),(EXPFTB,FTABI(4))	1051 66
*	1052 66
*BASIC OPTIONAL VARIABLES	1053 66
DIMENSION GRTMPI(3),GRTMPO(3)	1054 66
EQUIVALENCE(PIN,BSI),(TIN,BSI(2)),(TEX,BSI(3)),(TWMAX,	1055 66
1BSI(4)),(PSEX,BSI(5)),(PEX,BSI(6)),(W,BSI(7)),(QTOT,	1056 66
2BSI(8)),(PIND,BSO),(TIND,BSO(2)),(TEXD,BSO(3)),(TWMAXD,	1057 66
3BSO(4)),(PSEXD,BSO(5)),(PEXD,BSO(6)),(WD,BSO(7)),(QTOTD,	1058 66
4BSO(8)),(PSXOPI,BSI(9)),(PTXOPI,BSI(10)),(TEXOTI,BSI(11)),	1059 66
5(PSPID,BSO(9)),(PTPID,BSO(10)),(TXTID,BSO(11)),	1060 66
6(GRTMPI,BSI(2)),(GRTMPO,BSO(2))	1061 66
*	1062 66
EQUIVALENCE(COFHLM,HTABI),(EXHPLM,HTABI(2)),(EXHRLM,	1063 66
1HTABI(3)),(COFHTB,HTABI(4)),(EXHPTB,HTABI(5)),(EXHRTB,	1064 66
2HTABI(6))	1065 66
EQUIVALENCE(DPTIN,DPARAM),(DTTIN,DPARAM(2)),(DTTEX,DPARAM(3)),	1066 66
1(DTWMAX,DPARAM(4)),(DPSEX,DPARAM(5)),(DPTTEX,DPARAM(6)),(DW,DPARAM(	1067 66
27)),(DQTOT,DPARAM(8)),(NOPTIN,KPARAM),	1068 66
3(NOTTIN,KPARAM(2)),(NOTTEX,KPARAM(3)),(NOTWMX,NTWMAX,NOTWA,	1069 66
4KPARAM(4)),(NOPSEX,KPARAM(5)),(NOPTTEX,KPARAM(6)),(NOW,KPARAM(7)),	1070 66
5(NOQTOT,KPARAM(8))	1071 66
*	1072 66
* * * MASTER GROUPING	1073 66
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	1074 66
1BG(5474)	1075 66
EQUIVALENCE(RG0,RG1),(RG1,RG(101)),(RG2,RG(3801)),(RG3,RG(5173))	1076 66

COMMON BG	1077	663
* * * END OF MASTER GROUPING	1078	663
EQUIVALENCE(HEADER,HEDDUM(12))	1079	663
*FOR LOWER MEMORY IN INITIAL	1080	663
DIMENSION KNOPTL(2,10),KNPARL(4,13),KSHIFT(72),KUP(72)	1081	663
DIMENSION PRGSL(9)	1082	663
EQUIVALENCE(KSHIFT,KNOPTL),(KSHIFT(21),KNPARL),	1083	663
1(KUP,KONOPT),(KUP(21),KONPAR)	1084	663
*HOLLERITH GROUPING	1085	663
DIMENSION BWHEN(2),BINCH(4),BFOOT(4),BUNLEN(4,2),	1086	663
2BUNTMP(2)	1087	663
DIMENSION BLOW(12)	1088	663
EQUIVALENCE(BWHEN,BHIGH),(BUNLEN,BHIGH(3)),(BUNTMP,	1089	663
1BHIGH(11))	1090	663
*END OF STORAGE MAP	1091	663
TABLE KNOPTL(4,7, 4,7, 5,7, 5,7, 6,7, 6,7, 5,1, 5,1, 6,1,	1092	663
16,1),KNPARL(8,4,2,1, 3,4,2,1, 8,5,2,1, 3,5,2,1, 8,6,2,1,	1093	663
23,6,2,1, 8,7,5,2, 3,7,5,2, 8,7,2,6, 3,7,2,6, 8,7,2,1, 3,7,2,1,	1094	663
38,3,2,1)	1095	663
4,BLOW(72H INPUTOUTPUT INCHES, SQ. IN., PSIA, FEET, SQ. FT., PSF	1096	663
5A, DEG F,DEG R,)	1097	663
TABLE PRGSL(54HAIR N2 CO2 H2 O2 HE ARGON FREON NE	1098	663
10N)	1099	663
*	1100	663
CALL NEWSET(1)	1101	663
*DO OVERALL ZERO INITIALIZATION	1102	663
DO 100 L=1,5172	1103	663
100 BG(L)=0.	1104	663
*NON-ZERO INITIALIZATION	1105	663
*TRANSFER TO COMMON STORAGE	1106	663
DO 110 L=1,72	1107	663
110 KUP(L)=KSHIFT(L)	1108	663
B BLANKS=606060606060	1109	663
DO 120 L=1,12	1110	663
BHIGH(L)=BLOW(L)	1111	663
120 HEDDUM(L)=BLANKS	1112	663
DO 130 N=1,100	1113	663
CLSMOI(N)=1.	1114	663
FMULTI(N)=1.	1115	663
HMULTI(N)=1.	1116	663
130 CONTINUE	1117	663
DO 140 L=1,9	1118	663
140 PRGSL(L)=PRGSL(L)	1119	663
*	1120	663
ACCMNO=1.E-4	1121	663
ACCPRS=1.E-4	1122	663
ACCTMP=.049	1123	663
GAS=1.	1124	663
KASE=1	1125	663
KASTEP=1	1126	663
LIMCHK=10	1127	663
LIMPRS=40	1128	663
LIMTRY=15	1129	663
LMCHTO=30	1130	663
OMAXD=.5	1131	663
TRANHL=2000.	1132	663
TRANHU=8000.	1133	663

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TRANSF=2300.
*
RETURN
END(0,1,0)
* * * * *
* * * * *
*INPPRT INPUT DATA PRINTOUT FOR
*GFP 663 GENERAL FLOW PASSAGE
* S C SKIRVIN
*
SUBROUTINE INPPRT
*
*BEGIN STORAGE MAP
*GENERAL USAGE
DIMENSION
1AFFI (100 ),BSI (11 ),BSO (11 ),CLOSSI(100 ),CLSGEN(100 ),
2CLSMOI(100 ),DHI (100 ),DPARAM(8 ),DPARM(8 ),FMULTI(100 ),
3FTABI (8 ),FPARM(8 ),HTABI (6 ),HMULTI(100 ),KRSCON(4 ),
4KPARAM(8 ),KPARMR(8 ),NDH (100 ),NAFL (100 ),NLEN (100 ),
5NCLOSS(100 ),NCLSMO(100 ),NRINGD(100 ),NHMULT(100 ),NFMULT(100 ),
6OLENI (100 ),PHISUM(100 ),PHIEX (100 ),PO (100 ),PI (100 ),
7P2 (100 ),THICKD(100 ),TEXI (100 ),XOLD (100 ),BHIGH (12 ),
8HEDDUM(12 ),GMASS (100 ),TW (100 ),REYNO (100 ),FRIC (100 ),
9CONVEC(100 ),DPINT(100 ),OMEXI(100 ),PRTGAS(9)
DIMENSION PSEXI(100 ),PDYEXI(100 ),PEXI(100)
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP
EQUIVALENCE
1(AD ,BG0(1 )),(ACCMNO,BG0(2 )),(ACCPRS,BG0(3 )),
2(ACCTMP,BG0(4 )),(ALLRUN,BG0(5 )),(AUTOLS,BG0(6 )),
3(BD ,BG0(7 )),(BLANKS,BG0(8 )),(BETA1 ,BG0(9 )),
4(BETA2 ,BG0(10 )),(CIN ,BG0(11 )),(CEX ,BG0(12 )),
5(DEAD ,BG0(13 )),(DELH ,BG0(14 )),(DERIV ,BG0(15 )),
6(ENTRN ,BG0(16 )),(ENTRNC,BG0(17 )),(FD ,BG0(18 )),
7(FTIN ,BG0(19 )),(FTOUT ,BG0(20 )),(FSTPAR,BG0(21 )),
8(GOAL ,BG0(22 )),(GAS ,BG0(23 )),(HIN ,BG0(24 )),
9(ITRY ,BG0(25 )),(KTRCRD,BG0(26 )),(KALCNO,BG0(27 ))
EQUIVALENCE
1(KTCHAD,BG0(28 )),(KTWADJ,BG0(29 )),(KTCHTO,BG0(30 )),
2(KPOW ,BG0(31 )),(KOPT ,BG0(32 )),(KOSCIL,BG0(33 )),
3(KCHOKE,BG0(34 )),(KASE ,BG0(35 )),(KASTEP,BG0(36 )),
4(LOC ,BG0(37 )),(LIMCHK,BG0(38 )),(LMCHTO,BG0(39 )),
5(LIMTRY,BG0(40 )),(MORCAS,BG0(41 )),(NSKPPR,BG0(42 )),
6(NSKPHT,BG0(43 )),(NT ,BG0(44 )),(NHOT ,BG0(45 )),
7(NOPRT ,BG0(46 )),(NOSTGE,BG0(47 )),(PARPRT,BG0(48 )),
8(PRTSUM,BG0(49 )),(RNKIN ,BG0(50 )),(RNKOUT,BG0(51 )),
9(SVACMN,BG0(52 )),(SVACPR,BG0(53 )),(TOTLND,BG0(54 ))
EQUIVALENCE
1(TRY0 ,BG0(55 )),(TRY1 ,BG0(56 )),(TRY2 ,BG0(57 )),
2(TRY3 ,BG0(58 )),(TEST1 ,BG0(59 )),(TOTLEN,BG0(60 )),
3(WHI ,BG0(61 )),(WLO ,BG0(62 )),(YIELD0,BG0(63 )),
4(YIELD1,BG0(64 )),(YIELD2,BG0(65 )),(NOINPT,BG0(66 )),
5(LIMPRS,BG0(67 )),(PRTALL,BG0(68 )),(OMAXD ,BG0(69 )),
6(OMAX,BG0(70 )),(OMAX1,BG0(71 )),(KOPTH,BG0(72 )),
7 (DMCONV,BG0(75 )),(KDI,BG0(76 )),(KDD,BG0(77 )),(TRYMAX,BG0(
878 )),(MAXTMP,BG0(79 )),(LMBULK,BG0(80 )),(TBBULK,BG0(81 )),
9(KCHK1,BG0(1 )),(KCHK2,BG0(7 )),(KCHK3,BG0(18 )),(KGAS,BG0(82 ))
EQUIVALENCE(PDYIN,BG0(73 )),(PDYEX,BG0(74 )),(OMINI,BG0(83 ))

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1(OMEXIT,BG0(84)),(DPIN,BG0(85)),(DPEX,BG0(86))	1191 663
2,(TRANSF,BG0(87)),(TRANHL,BG0(88)),(TRANHU,BG0(89))	1192 663
3,UNEWSETTBG0U 0D)T(KTPA-,BG0U 1DDT8	0 2 552
4(QQQBAR,BG0(94)),(NOGEOM,BG0(95))	1194 663
EQUIVALENCE	1195 663
1(AFFD ,BG1(2)),(AFFI ,BG1(102)),(BSI ,BG1(202)),	1196 663
2(BSO ,BG1(213)),(BHIGH ,BG1(224)),(CLOSSI,BG1(237)),	1197 663
3(CLSGEN,BG1(337)),(CLSM DI,BG1(438)),(DHD ,BG1(539)),	1198 663
4(DHI ,BG1(639)),(DPARAM,BG1(739)),(DPARMI,BG1(747)),	1199 663
5(FTABI ,BG1(755)),(FPARMI,BG1(759)),(FMULTI,BG1(768)),	1200 663
6(GMASS ,BG1(868)),(HTABI ,BG1(968)),(HEDDUM,BG1(974)),	1201 663
7(HMULTI,BG1(987)),(KPARAM,BG1(1087)),(KPARMR,BG1(1095)),	1202 663
8(KRSCON,BG1(1103)),(NDH ,BG1(1107)),(NAFL ,BG1(1207)),	1203 663
9(NLEN ,BG1(1307)),(NCLOSS,BG1(1407)),(NCLSM D,BG1(1507))	1204 663
EQUIVALENCE	1205 663
1(NHMULT,BG1(1607)),(NFMULT,BG1(1707)),(OLEND ,BG1(1808)),	1206 663
2(OLENI ,BG1(1908)),(PHISUM,BG1(2008)),(PHIEX ,BG1(2108)),	1207 663
3(P0 ,BG1(2208)),(P1 ,BG1(2308)),(P2 ,BG1(2408)),	1208 663
4(TEXI ,BG1(2508)),(TW ,BG1(2608)),(XOLD ,BG1(2708)),	1209 663
5(XOL ,BG1(2808)),(REYNO ,BG1(2908)),(FRIC ,BG1(3008)),	1210 663
6(CONVEC,BG1(3108)),(DPINT,BG1(3208)),(OMEXI,BG1(3308))	1211 663
7,(PRTGAS,BG1(3408)),(PSEXI,BG1(3417)),(PDYEXI,BG1(3517))	1212 663
*OPEN AT 3617, KEEP OPEN UNTIL 3700	1213 663
DIMENSION KONOPT(2,10),KONPAR(4,13),SAVTAB(13,100),KSVTAB(13,100)	1214 663
EQUIVALENCE(KONOPT,KUP,BG2),(KONPAR,BG2(21)),	1215 663
1(SAVTAB,KSVTAB,BG2(73))	1216 663
*OPEN 1373	1217 663
EQUIVALENCE(THICKD,BG3(2)),(NRINGD,BG3(103)),(PEXI,BG3(203))	1218 663
*	1219 663
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2)),(COFFTB,	1220 663
1FTABI(3)),(EXPFTB,FTABI(4))	1221 663
*	1222 663
*BASIC OPTIONAL VARIABLES	1223 663
DIMENSION GRTMPI(3),GRTMPO(3)	1224 663
EQUIVALENCE(PIN,BSI),(TIN,BSI(2)),(TEX,BSI(3)),(TWMAX,	1225 663
1BSI(4)),(PSEX,BSI(5)),(PEX,BSI(6)),(W,BSI(7)),(QTOT,	1226 663
2BSI(8)),(PIND,BSO),(TIND,BSO(2)),(TEXD,BSO(3)),(TWMAXD,	1227 663
3BSO(4)),(PSEX D,BSO(5)),(PEXD,BSO(6)),(WD,BSO(7)),(QTOTD,	1228 663
4BSO(8)),(PSXOPI,BSI(9)),(PTXOPI,BSI(10)),(TEXOTI,BSI(11)),	1229 663
5(PSPID,BSO(9)),(PTPID,BSO(10)),(TXTID,BSO(11)),	1230 663
6(GRTMPI,BSI(2)),(GRTMPO,BSO(2))	1231 663
*	1232 663
EQUIVALENCE(COFHLM,HTABI),(EXHPLM,HTABI(2)),(EXHRLM,	1233 663
1HTABI(3)),(COFH TB,HTABI(4)),(EXHPTB,HTABI(5)),(EXHRTB,	1234 663
2HTABI(6))	1235 663
EQUIVALENCE(DPTIN,DPARAM),(DTTIN,DPARAM(2)),(DTTEX,DPARAM(3)),	1236 663
1(DTWMAX,DPARAM(4)),(DPSEX,DPARAM(5)),(DPTEX,DPARAM(6)),(DW,DPARAM	1237 663
27)),(DQTOT,DPARAM(8)),(NOPTIN,KPARAM),	1238 663
3(NOTTIN,KPARAM(2)),(NOTTEX,KPARAM(3)),(NOTWMX,NTWMAX,NOTWA,	1239 663
4KPARAM(4)),(NOPSEX,KPARAM(5)),(NOPTEX,KPARAM(6)),(NOW,KPARAM(7)),	1240 663
5(NOQTOT,KPARAM(8))	1241 663
* * * MASTER GROUPING	1242 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	1243 663
1BG(5474)	1244 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	1245 663
COMMON BG	1246 663
* * * END OF MASTER GROUPING	1247 663

*		1248 66
*LIMITED USAGE		1249 66
	DIMENSION AFFD(100),DHD(100),OLEND(100),XOL(100)	1250 66
	EQUIVALENCE(AFFD,AFF(2)),(CLOSSI,CLOSS(2)),(CLSM DI,CLSMOD(2)),	1251 66
	1(DHD,DH(2)),(DH,DOUTER,ELPAJ,WIDTH),(AFF,DINNER,ELPMIN,	1252 66
	2HEIGHT),(FMULTI,FMULT(2)),(HMULTI,HMULT(2)),(ROUND,KRSCON),	1253 66
	3(RECTNG,KRSCON(2)),(ELLIPS,KRSCON(3)),(RINGS,KRSCON(4)),	1254 66
	4(OLEND,LENGTH(2)),(NRINGD,NORING(2)),(NAFF,NAFL),(THICKD,	1255 66
	5THICK(2)),(PTIN,PIN),(TTIN,TIN),(PTEX,PEX),(TEX,TTEX),	1256 66
	6(CASE,KASE),(CASTEP,KASTEP),(DHD,DHG),(DH,DHGSUB),(AFF,	1257 66
	7AFFSUB),(OLEND,OL),(LENGTH,OLSUB),(ACCMNO,PER),(NOSTGE,MN),	1258 66
	8(HTABI(4),A1),(FTABI(3),B1),(FTABI(4),OM),(FMULTI,AKF),(HMULTI,	1259 66
	9AKH),(CIN,C1),(CEX,C2),(PHISUM,A2),(PHIEX,Q),(NLEN,NOL)	1260 66
	EQUIVALENCE(NDH,NDHG),(MAXMNO,OMAXD)	1261 66
*ALL MODIFIED OFF-DESIGN(ANP 443) INPUT VARIABLES		1262 66
* ARE IN DIP LIST, FUNCTIONALLY WHEREVER POSSIBLE		1263 66
	DIMENSION PRTCRS(2,5),CRSHD1(8,4),CRSHD2(8,4)	1264 66
	TABLE PRTCRS(60HGENERAL ROUND RECTANGULAR ELLIPTICAL CO	1265 66
	1NC. RINGS),CRSHD1(192H HYDR. FLOW	1266 66
	2	
	3 MINOR MAJOR	1267 66
	4RING NO),CRSHD2(192H DIAM OUTER INNER	1268 66
	5 WIDTH HEIGHT AREA	1269 66
	6AXIS AXIS DIAM DIAM	1270 66
	7 THICK RINGS)	1271 66
*END OF STORAGE MAP		1272 66
*		1273 66
	KOPT=KOPT	1274 66
	KGAS=GAS	1275 66
*CHECK CONTROLS		1276 66
	IF(KALCNO)100,110,100	1277 66
	100 IF(MORCAS)105,107,105	1278 66
*EXIT FROM SR IF PARAMETRIC AND NOT FIRST CASE		1279 66
	105 IF(FSTPAR)540,540,107	1280 66
	107 IF(PARPRT)110,110,108	1281 66
	108 KRT=2	1282 66
	GO TO 160	1283 66
*COMPLETE PRINTOUT - SETUP		1284 66
	110 KRT=1	1285 66
*CROSS SECTION IDENTIFICATION PRINT		1286 66
	KD1=1	1287 66
	DO 130 L=1,4	1288 66
	IF(KRSCON(L))130,130,120	1289 66
	120 KD1=L+1	1290 66
	GO TO 140	1291 66
	130 CONTINUE	1292 66
*FORMAT SELECTION CONTROL FOR CROSS SECTION		1293 66
	140 KD2=0	1294 66
	IF(KD1-5)160,150,150	1295 66
	150 KD2=1	1296 66
*UNIT HEADING PRINTOUT - LENGTH		1297 66
	160 KD3=1	1298 66
	IF(FTIN)180,180,170	1299 66
	170 KD3=2	1300 66
*TEMP		1301 66
	180 KD4=1	1302 66
	IF(RNKIN)220,220,190	1303 66
		1304 66

190 KD4=2	1305 663
*PRINT UNIT HEADING	1306 663
220 CALL PRTUNT(1,KD3,KD4)	1307 663
GO TO(230,520,245,320,330,400,410,531),KRT	1308 663
*UNPROCESSED GEOMETRY	1309 663
230 IF(NOGEOM)460,232,460	1310 663
232 KD5=1	1311 663
IF(KD1-2)240,240,235	1312 663
235 KD5=KD1-1	1313 663
240 PRINT 32005,KASE,TOTLEN,(PRTCRS(L,KD1),L=1,2)	1314 663
32005 FORMAT	1315 663
SPACE	1316 663
CASE -I ORIGINAL GEOMETRICAL INPUT DATA	1317 663
SPACE	1318 663
TOTAL LENGTH = -1PE4 CROSS SECTION IS-X	-A 1319 663
END OF FORMAT	1320 663
*	1321 663
245 PRINT 32006,(CRSHD1(L,KD5),L=1,8),(CRSHD2(L,KD5),L=1,8)	1322 663
32006 FORMAT	1323 663
SPACE	1324 663
-X	-A 1325 663
STGE X/L LENGTH	-A 1326 663
SPACE	1327 663
END OF FORMAT	1328 663
*	1329 663
IF(KRT-2)250,520,260	1330 663
250 NL=1	1331 663
NU=NOSTGE	1332 663
EXIT=1.	1333 663
IF(40-NOSTGE)255,260,260	1334 663
255 NU=40	1335 663
EXIT=0.	1336 663
260 IF(KD2)270,265,270	1337 663
*NOT CONCENTRIC RING	1338 663
265 PRINT 32007,(N,XOL(N),OLEND(N),DHD(N),AFFD(N),	1339 663
IN=NL,NU)	1340 663
32007 FORMAT((I4,OPF8.4,1P3E12.4))	1341 663
GO TO 280	1342 663
*CONCENTRIC RINGS	1343 663
270 PRINT 32008,(N,XOL(N),OLEND(N),DHD(N),AFFD(N),THICKD(N),	1344 663
1NRINGD(N),N=NL,NU)	1345 663
32008 FORMAT((I4,OPF8.4,1P4E12.4,I6))	1346 663
280 IF(EXIT)285,285,300	1347 663
285 NL=NU+1	1348 663
KRT=3	1349 663
IF(84-NOSTGE)290,295,295	1350 663
290 IF(84-NU)295,295,297	1351 663
295 NU=NOSTGE	1352 663
EXIT=1.	1353 663
GO TO 220	1354 663
297 NU=84	1355 663
GO TO 220	1356 663
*	1357 663
*PROCESSED GEOMETRY	1358 663
300 KRT=4	1359 663
NL=1	1360 663
NU=NOSTGE	1361 663

IF(40-NOSTGE)310,220,220	1362	66
310 NU=40	1363	66
EXIT=0.	1364	66
GO TO 220	1365	66
320 PRINT 32010,KASE,TOTLND,(PRTCRS(L,KD1),L=1,2)	1366	66
32010 FORMAT	1367	66
SPACE	1368	66
CASE -I PROCESSED GEOMETRICAL INPUT AND F- AND H-MULTIPLIERS	1369	66
SPACE	1370	66
TOTAL LENGTH = -1PE4 CROSS SECTION IS-X -A	1371	66
END OF FORMAT	1372	66
*	1373	66
330 PRINT 32012,(N,XOLD(N),OLENI(N),DHI(N),AFFI(N),HMULTI(N),	1374	66
1FMULTI(N),N=NL,NU)	1375	66
32012 FORMAT	1376	66
SPACE	1377	66
STGE X/L LENGTH HYDR. FLOW H- F-	1378	66
DIAM AREA MULT MULT	1379	66
SPACE	1380	66
-I -0PF4 -1PE5 -E5 -E5 -0PF4 -F4	1381	66
REPEAT 1	1382	66
END OF FORMAT	1383	66
*	1384	66
IF(EXIT)340,340,380	1385	66
340 NL=NU+1	1386	66
KRT=5	1387	66
IF(84-NOSTGE)350,350,360	1388	66
350 IF(84-NU)360,360,370	1389	66
360 NU=NOSTGE	1390	66
EXIT=1.	1391	66
GO TO 220	1392	66
370 NU=84	1393	66
GO TO 220	1394	66
*	1395	66
*REMAINING STAGewise INPUT	1396	66
380 KRT=6	1397	66
NL=1	1398	66
NU=NOSTGE	1399	66
IF(38-NOSTGE)390,220,220	1400	66
390 NU=38	1401	66
EXIT=0.	1402	66
GO TO 220	1403	66
400 PRINT 32015,KASE,AUTOLS,ENTRNC,BETA1,BETA2	1404	66
32015 FORMAT	1405	66
SPACE	1406	66
CASE -I POWER PROFILE AND INTERSTAGE LOSS INPUT	1407	66
SPACE	1408	66
AUTOLOSS CALC =-F0	1409	66
INTENDED ENTRANCE LENGTH EFFECT =-F0	1410	66
BETA1 = -1PE4 BETA2 = -E4	1411	66
END OF FORMAT	1412	66
*	1413	66
410 PRINT 32017,(N,CLOSSI(N),CLSM DI(N),PHISUM(N),PHIEX(N),	1414	66
1PO(N),P1(N),P2(N),N=NL,NU)	1415	66
32017 FORMAT	1416	66
SPACE	1417	66
INTRSTGE AUTO LOSS	1418	66

STGE	LOSS COF	MULT	PHISUM	PHIEX	P0	P1	P2	1419	663
	SPACE							1420	663
-I	-OPF4	-F4	-F4	-F4	-F4	-F4	-F4	1421	663
	REPEAT 1							1422	663
	END OF FORMAT							1423	663
*								1424	663
	IF(EXIT)420,420,460							1425	663
420	NL=NU+1							1426	663
	KRT=7							1427	663
	IF(80-NOSTGE)430,430,440							1428	663
430	IF(80-NU)440,440,450							1429	663
440	NU=NOSTGE							1430	663
	EXIT=1.							1431	663
	GO TO 220							1432	663
450	NU=80							1433	663
	GO TO 220							1434	663
*CHECK	NEED FOR LENGTH UNIT CHANGES							1435	663
460	IF(FTIN)470,510,470							1436	663
470	DO 480 N=1,NOSTGE							1437	663
	DHI(N)=DHI(N)*12.							1438	663
	OLENI(N)=OLENI(N)*12.							1439	663
	AFFI(N)=AFFI(N)*144.							1440	663
480	CONTINUE							1441	663
	TOTLND=TOTLND*12.							1442	663
*								1443	663
*FLOW	INPUT DATA							1444	663
510	KRT=2							1445	663
	GO TO 220							1446	663
520	PRINT 32020,KASE,PRTGAS(KGAS),GAS,KOPT,(HTABI(L),							1447	663
	1L31,6),(FTAB+(LDTL31T-D,\$MBULK,KBULK)3								
	2*EOTQSEOT,EOTQXOP-G,,EOPT+9								2
	3,ACCPRS,ACCMNO,ACCTMP,LIMTRY,LIMCHK,LMCHTO,LIMPRS								KKNC0-KG0-OC+W33 Q 52
32020	FORMAT							1450	663
	SPACE							1451	663
CASE	-I FLOW INPUT DATA (GAS IS-X -A,NO -FO)							1452	663
	* * * WILL EXECUTE OPTION NO -I * * *							1453	663
	SPACE							1454	663
	FRICTION FACT AND HEAT TRANSFER CORRELATION FORMS							1455	663
	N(NUS)=A*(N(PR)**B)*(N(RE)**C)							1456	663
	F=D*(N(RE)**E)							1457	663
	NUMERICAL VALUES (L FOR LAMINAR, T FOR TURBULENT)							1458	663
	AL= -1PE3, BL= -E3, CL= -E3							1459	663
	AT= -E3, BT= -E3, CT= -E3							1460	663
	DL= -E3, EL= -E3, DT= -E3, ET= -E3							1461	663
	SPACE							1462	663
	BULK TEMP FOR HEAT TRANSFER CORRELATION(0=NO, 1=YES)							1463	663
	LAMINAR ==I TURBULENT ==I							1464	663
	SPACE							1465	663
	TRANSITION RANGE FOR N(NU)		-1PE4 TO			-E4		1466	663
	TRANSITION FOR FRICTION AT		-E4					1467	663
	SPACE							1468	663
	TOTAL PRESS	STATIC PRESS		TOTAL TEMP				1469	663
INLET	-1PE5			-OPF2				1470	663
EXIT	-1PE5	-E5		-OPF2				1471	663
EX/IN	-F5			-F5				1472	663
	PSEX/PTIN =	-F5						1473	663
								1474	663
								1475	663

WEIGHT FLOW =	-1PE5	HEAT RELEASE =	-E5	1476	66
QBAR =	-E5	Q/QBAR =	-E5	1477	66
MAX WALL TEMP =	-OPF2	AT STAGE NO	-I	1478	66
SPACE 2				1479	66
ACCURACIES (FRACTIONAL UNLESS NOTED)				1480	66
PRESS	MACH NO	WALL TEMP(DEG)		1481	66
-1PE3	-E3	-OPF2		1482	66
SPACE				1483	66
COUNTER LIMITS ON ITERATIONS				1484	66
OPTION ITERATION =	-I			1485	66
CHOKES/WT FLOW =	-I	CHOKES/CASE =	-I	1486	66
STAGE PRESS AND WALL TEMP =	-I			1487	66
END OF FORMAT				1488	66
*				1489	66
IF(FSTPAR)540,540,530				1490	66
530 KTOTPR=1				1491	66
KRT=8				1492	66
GO TO 220				1493	66
531 DO 534 K=1,4				1494	66
KD=KONPAR(K,KOPT)				1495	66
IF(KPARMR(KD))532,534,534				1496	66
532 KPARMR(KD)=0				1497	66
534 KTOTPR=KTOTPR*(KPARMR(KD)+1)				1498	66
PRINT 32025,KASE,KTOTPR,DPARAM(3),DPARAM(7),DPARAM(6),				1499	66
1DPARAM(5),KPARAM(3),KPARAM(7),KPARAM(6),KPARAM(5),				1500	66
2DPARAM(8),DPARAM(4),DPARAM(2),DPARAM(1),				1501	66
3KPARAM(8),KPARAM(4),KPARAM(2),KPARAM(1)				1502	66
32025 FORMAT				1503	66
SPACE 2				1504	66
CASE -I	PARAMETRIC SETUP (	-I CASES)		1505	66
SPACE				1506	66
	EXIT	WEIGHT	EXIT TOT	EXIT STAT	
	TEMP	FLOW	PRESS	PRESS	
SPACE					1509
INCREMENT	-1PE4	-E4	-E4	-E4	1510
NO OF TIMES	-I	-I	-I	-I	1511
SPACE 2					1512
	HEAT	MAX AVE	INLET	INLET TOT	
	RELEASE	SURF TEMP	TEMP	PRESS	
SPACE					1515
INCREMENT	-E4	-E4	-E4	-E4	1516
NO OF TIMES	-I	-I	-I	-I	1517
END OF FORMAT					1518
*					1519
*SR FINISHED					1520
540 CONTINUE					1521
RETURN					1522
END(0,0,0)					1523
* * * * *					1524
*ITRCON SR WHICH CONTROLS EXECUTION OF CALCULATION					1525
* OPTION FOR					1526
*GFP 663 GENERAL FLOW PASSAGE					1527
* S C SKIRVIN					1528
*					1529
SUBROUTINE ITRCON					1530
*					1531
*REGIN STORAGE MAP					1532

*GENERAL USEAGE		1533 663
DIMENSION		1534 663
1AFFI (100),BSI (11),BSO (11),CLOSSI(100),CLSGEN(100),		1535 663
2CLSM DI(100),DHI (100),DPARAM(8),DPARMI(8),FMULTI(100),		1536 663
3FTABI (8),FPARMI(8),HTABI (6),HMULTI(100),KRSCON(4),		1537 663
4KPARAM(8),KPARMR(8),NDH (100),NAFL (100),NLEN (100),		1538 663
5NCLOSS(100),NCLSM DI(100),NRINGD(100),NHMULT(100),NFMULT(100),		1539 663
6OLENI (100),PHISUM(100),PHIEX (100),PO (100),P1 (100),		1540 663
7P2 (100),THICKD(100),TEXI (100),XOLD (100),BHIGH (12),		1541 663
8HEDDUM(12),GMASS (100),TW (100),REYNO (100),FRIC (100),		1542 663
9CONVEC(100),DPINT(100),OMEXI(100),PRTGAS(9)		1543 663
DIMENSION PSEXI(100),PDYEXI(100),PEXI(100)		1544 663
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP		1545 663
EQUIVALENCE		1546 663
1(AD ,BG0(1)),(ACCMNO,BG0(2)),(ACCPRS,BG0(3)),		1547 663
2(ACCTMP,BG0(4)),(ALLRUN,BG0(5)),(AUTOLS,BG0(6)),		1548 663
3(BD ,BG0(7)),(BLANKS,BG0(8)),(BETA1 ,BG0(9)),		1549 663
4(BETA2 ,BG0(10)),(CIN ,BG0(11)),(CEX ,BG0(12)),		1550 663
5(DEAD ,BG0(13)),(DELH ,BG0(14)),(DERIV ,BG0(15)),		1551 663
6(ENTRN ,BG0(16)),(ENTRNC,BG0(17)),(FD ,BG0(18)),		1552 663
7(FTIN ,BG0(19)),(FTOUT ,BG0(20)),(FSTPAR,BG0(21)),		1553 663
8(GOAL ,BG0(22)),(GAS ,BG0(23)),(HIN ,BG0(24)),		1554 663
9(ITRY ,BG0(25)),(KTRCRD,BG0(26)),(KALCNO,BG0(27))		1555 663
EQUIVALENCE		1556 663
1(KTCHAD,BG0(28)),(KTWADJ,BG0(29)),(KTCHTO,BG0(30)),		1557 663
2(KPOW ,BG0(31)),(KOPT ,BG0(32)),(KOSCIL,BG0(33)),		1558 663
3(KCHOKE,BG0(34)),(KASE ,BG0(35)),(KASTEP,BG0(36)),		1559 663
4(LOC ,BG0(37)),(LIMCHK,BG0(38)),(LMCHTO,BG0(39)),		1560 663
5(LIMTRY,BG0(40)),(MORCAS,BG0(41)),(NSKPPR,BG0(42)),		1561 663
6(NSKPHT,BG0(43)),(NT ,BG0(44)),(NHOT ,BG0(45)),		1562 663
7(NOPRT ,BG0(46)),(NOSTGE,BG0(47)),(PARPRT,BG0(48)),		1563 663
8(PRTSUM,BG0(49)),(RNKIN ,BG0(50)),(RNKOUT,BG0(51)),		1564 663
9(SVACMN,BG0(52)),(SVACPR,BG0(53)),(TOTLND,BG0(54))		1565 663
EQUIVALENCE		1566 663
1(TRY0 ,BG0(55)),(TRY1 ,BG0(56)),(TRY2 ,BG0(57)),		1567 663
2(TRY3 ,BG0(58)),(TEST1 ,BG0(59)),(TOTLEN,BG0(60)),		1568 663
3(WHI ,BG0(61)),(WLO ,BG0(62)),(YIELD0,BG0(63)),		1569 663
4(YIELD1,BG0(64)),(YIELD2,BG0(65)),(NOINPT,BG0(66)),		1570 663
5(LIMPRS,BG0(67)),(PRTALL,BG0(68)),(OMAXD ,BG0(69)),		1571 663
6(OMAX,BG0(70)),(OMAX1,BG0(71)),(KOPTH,BG0(72)),		1572 663
7(DMCONV,BG0(75)),(KDI,BG0(76)),(KDD,BG0(77)),(TRYMAX,BG0(	1573 663	
878)),(MAXTMP,BG0(79)),(LMBULK,BG0(80)),(TBBULK,BG0(81)),		1574 663
9(KCHK1,BG0(1)),(KCHK2,BG0(7)),(KCHK3,BG0(18)),(KGAS,BG0(82))		1575 663
EQUIVALENCE(PDYIN,BG0(73)),(PDYEX,BG0(74)),(OMINLT,BG0(83)),		1576 663
1(OMEXIT,BG0(84)),(DPIN,BG0(85)),(DPEX,BG0(86))		1577 663
2,(TRANSF,BG0(87)),(TRANHL,BG0(88)),(TRANHU,BG0(89))		1578 663
3,(NEWSET,BG0(90)),(KTPAR,BG0(91)),(KTOTPR,BG0(92)),(QBAR,BG0(93)),		1579 663
4(QOQBAR,BG0(94)),(NOGEOM,BG0(95))		1580 663
EQUIVALENCE		1581 663
1(AFFD ,BG1(2)),(AFFI ,BG1(102)),(BSI ,BG1(202)),		1582 663
2(BSO ,BG1(213)),(BHIGH ,BG1(224)),(CLOSSI,BG1(237)),		1583 663
3(CLSGEN,BG1(337)),(CLSM DI,BG1(438)),(DHD ,BG1(539)),		1584 663
4(DHI ,BG1(639)),(DPARAM,BG1(739)),(DPARMI,BG1(747)),		1585 663
5(FTABI ,BG1(755)),(FPARMI,BG1(759)),(FMULTI,BG1(768)),		1586 663
6(GMASS ,BG1(868)),(HTABI ,BG1(968)),(HEDDUM,BG1(974)),		1587 663
7(HMULTI,BG1(987)),(KPARAM,BG1(1087)),(KPARMR,BG1(1095)),		1588 663
8(KRSCON,BG1(1100)),(NDH ,BG1(1107)),(NAFL ,BG1(1207)),		1589 663

9(NLEN ,BG1(1307)),(NCLOSS,BG1(1407)),(NCLSDM,BG1(1507))	1590 66
EQUIVALENCE	1591 66
1(NHMULT,BG1(1607)),(NFMULT,BG1(1707)),(OLEND ,BG1(1808)),	1592 66
2(OLENI ,BG1(1908)),(PHISUM,BG1(2008)),(PHIEX ,BG1(2108)),	1593 66
3(P0 ,BG1(2208)),(P1 ,BG1(2308)),(P2 ,BG1(2408)),	1594 66
4(TEXI ,BG1(2508)),(TW ,BG1(2608)),(XOLD ,BG1(2708)),	1595 66
5(XOL ,BG1(2808)),(REYNO ,BG1(2908)),(FRIC ,BG1(3008)),	1596 66
6(CONVEC,BG1(3108)),(DPINT,BG1(3208)),(OMEXI,BG1(3308))	1597 66
7,(PRTGAS,BG1(3408)),(PSEXI,BG1(3417)),(PDYEXI,BG1(3517))	1598 66
*OPEN AT 3617, KEEP OPEN UNTIL 3700	1599 66
DIMENSION KONOPT(2,10),KONPAR(4,13),SAVTAB(13,100),KSVTAB(13,100)	1600 66
EQUIVALENCE(KONOPT,KUP,BG2),(KONPAR,BG2(21)),	1601 66
1(SAVTAB,KSVTAB,BG2(73))	1602 66
*OPEN 1373	1603 66
EQUIVALENCE(THICKD,BG3(2))),(NRINGD,BG3(103))),(PEXI,BG3(203))	1604 66
*	1605 66
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2))),(COFFTB,	1606 66
1FTABI(3))),(EXPFTB,FTABI(4))	1607 66
*	1608 66
*BASIC OPTIONAL VARIABLES	1609 66
DIMENSION GRTMPI(3),GRTMPO(3)	1610 66
EQUIVALENCE(PIN,BSI),(TIN,BSI(2))),(TEX,BSI(3))),(TWMAX,	1611 66
1BSI(4))),(PSEX,BSI(5))),(PEX,BSI(6))),(W,BSI(7))),(QTOT,	1612 66
2BSI(8))),(PIND,BSO),(TIND,BSO(2))),(TEXD,BSO(3))),(TWMAXD,	1613 66
3BSO(4))),(PSEXD,BSO(5))),(PEXD,BSO(6))),(WD,BSO(7))),(QTOTD,	1614 66
4BSO(8))),(PSXOPI,BSI(9))),(PTXOPI,BSI(10))),(TEXOTI,BSI(11)),	1615 66
5(PSPID,BSO(9))),(PTPID,BSO(10))),(TXTID,BSO(11)),	1616 66
6(GRTMPI,BSI(2))),(GRTMPO,BSO(2))	1617 66
*	1618 66
EQUIVALENCE(COFHLM,HTABI),(EXHPLM,HTABI(2))),(EXHRLM,	1619 66
1HTABI(3))),(COFHTB,HTABI(4))),(EXHPTB,HTABI(5))),(EXHRTB,	1620 66
2HTABI(6))	1621 66
EQUIVALENCE(DPTIN,DPARAM),(DTTIN,DPARAM(2))),(DTTEX,DPARAM(3)),	1622 66
1(DTWMAX,DPARAM(4))),(DPSEX,DPARAM(5))),(DPTEX,DPARAM(6))),(DW,DPARAM(	1623 66
27))),(DQTOT,DPARAM(8))),(NOPTIN,KPARAM),	1624 66
3(NOTTIN,KPARAM(2))),(NOTTEX,KPARAM(3))),(NOTWMX,NTWMAX,NOTWA,	1625 66
4KPARAM(4))),(NOPSEX,KPARAM(5))),(NOPTX,KPARAM(6))),(NOW,KPARAM(7)),	1626 66
5(NOQTOT,KPARAM(8))	1627 66
*	1628 66
* * * MASTER GROUPING	1629 66
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	1630 66
1BG(5474)	1631 66
EQUIVALENCE(BG0,BG),(BG1,BG(101))),(BG2,BG(3801))),(BG3,BG(5173))	1632 66
COMMON BG	1633 66
* * * END OF MASTER GROUPING	1634 66
DIMENSION TSTGRP(4)	1635 66
EQUIVALENCE(TRYP,TSTGRP),(TESTP,TSTGRP(2))),(TRYM,TSTGRP(3)),	1636 66
1(TESTM,TSTGRP(4))	1637 66
*END OF STORAGE MAP	1638 66
*	1639 66
KOPT=KOPT	1640 66
SVACMN=ACCMNO	1641 66
SVACPR=ACCPRS	1642 66
*INITIALIZATION	1643 66
KCHOKE=0	1644 66
HIN=TMPENT(TIND,GAS,1)	1645 66
*ARE ANY OPTIONS BEING EXERCISED	1646 66

1090 IF(NSKPHT)1250,1095,1250	1647 663
1095 IF(NSKPPR)1250,1100,1250	1648 663
*MAKE PRE-CALCULATION SETUP	1649 663
1100 IF(KOPHT)1145,1105,1105	1650 663
*PRE-ITERATION INITIALIZATION	1651 663
*GOAL IS DESIRED VALUE OF DEPENDENT VARIABLE	1652 663
*TRY0,1,2,3 ARE RUNNING VALUES OF INDEPENDENT VARIABLE	1653 663
1105 KOSCIL=0	1654 663
ITRY=1	1655 663
KTCHTO=0	1656 663
KTWADJ=0	1657 663
OMAX1=OMAXD	1658 663
TRYMAX=0.	1659 663
TRYMIN=1.E+20	1660 663
WHI=1.E+20	1661 663
WLO=0.	1662 663
DO 1106 L=1,4	1663 663
BGO(L+54)=0.	1664 663
1106 TSTGRP(L)=0.	1665 663
*KONOPT(2,KOPT) RETRIEVES INDEPENDENT VARIABLE FROM BSO	1666 663
KDI=KONOPT(2,KOPT)	1667 663
*KONOPT(1,KOPT) RETRIEVES DEPENDENT VARIABLE FROM BSO	1668 663
KDD=KONOPT(1,KOPT)	1669 663
CALL XPRNT(6HKDI,DD,KDI,KALCNO,2,KCHK1)	1670 663
IF(KDI-1)1111,1108,1107	1671 663
1107 WHI=FLWFUN(AFFI(1),PIND,TIND,.9,GAS)	1672 663
GO TO 1111	1673 663
1108 WLO=PRSFUN(AFFI(1),WD,TIND,.9,GAS)	1674 663
*SET CONVERGENCE CRITERIA	1675 663
1111 IF(KOPT-2)1112,1112,1113	1676 663
1112 DMCONV=ACCTMP	1677 663
GO TO 1114	1678 663
1113 DMCONV=ACCPRS	1679 663
1114 CONTINUE	1680 663
CALL FPRNT(6HDMCONV,DMCONV,ITRY,1,KCHK1)	1681 663
IF(BSO(KDI))1115,1115,1140	1682 663
1115 IF(6 KOPT)1130,1120,1120	1683 663
*CHECK IF STARTING VALUE NEEDED	1684 663
1120 IF(WD)1125,1125,1140	1685 663
1125 WD=FLWFUN(AFFI(1),PIND,TIND,.1,GAS)	1686 663
GO TO 1140	1687 663
1130 PIND=PRSFUN(AFFI(1),WD,TIND,.1,GAS)	1688 663
1140 TRY0=BSO(KDI)	1689 663
GOAL=BSO(KDD)	1690 663
CALL FPRNT(4HGOAL,GOAL,ITRY,1,KCHK1)	1691 663
1145 CONTINUE	1692 663
IF(13-KOPT)1147,1147,1148	1693 663
*FLOW NOT USER-SUPPLIED	1694 663
1147 WD=QTOTD/(TMPENT(TEXD,GAS,1)-HIN)	1695 663
GO TO 1170	1696 663
*CHECK IF TEXD USER-SUPPLIED	1697 663
1148 KRT=1	1698 663
1149 DO 1150 M=1,7	1699 663
IF(KOPT-2*M+1)1150,1160,1150	1700 663
1150 CONTINUE	1701 663
GO TO 1165	1702 663
1160 TEXD=TMPENT(QTOTD/WD+HIN,GAS,-1)	1703 663

1165 GO TO(1170,1476),KRT	1704 663
1170 CONTINUE	1705 663
T2=BSO(KDI)	1706 663
CALL FPRNT(3HBSO,BSO,ITRY,11,KCHK1)	1707 663
*	1708 663
*ITERATION SECTION	1709 663
1250 CONTINUE	1710 663
*CALC BULK TEMPS TO PERMIT INDEPENDENT USE OF	1711 663
* PRES DROP OR WALL TEMP ROUTINES	1712 663
* ALSO CALC MASS VELOCITIES	1713 663
1251 DELH=TMPENT(TEXD,GAS,1)-HIN	1714 663
DO 1252 N=1,NOSTGE	1715 663
GMASS(N)=WD/AFFI(N)	1716 663
1252 TEXI(N)=TMPENT(PHISUM(N)*DELH+HIN,GAS,-1)	1717 663
IF(NSKPPR)13502,1254,13502	1718 663
*MAKE PRESSURE DROP CALC	1719 663
1254 CALL DPFRLT(0)	1720 663
IF(NSKPHT)1600,1255,1600	1721 663
*DID STAGE EXIT PRESS FAIL TO CONVERGE	1722 663
1255 IF(SENSE LIGHT 2)1505,1256	1723 663
1256 CONTINUE	1724 663
*	1725 663
1259 KTCHAD=0	1726 663
*DID CHOKE OCCUR	1727 663
IF(KCHOKE)1260,13500,1260	1728 663
1260 NT=160	1729 663
CALL FPRNT(5HWHILO,WHI,KTCHTO,2,KCHK1)	1730 663
IF(KOPHT)1262,1270,1270	1731 663
*OPTIONS 11-13 HAVE NO CHOKE REMEDIAL	1732 663
1262 LOC=1	1733 663
GO TO 1500	1734 663
*HAS TOTAL ADJ COUNTER BEEN EXCEEDED	1735 663
1270 IF(LMCHTO-KTCHTO)1272,1272,1280	1736 663
1272 LOC=3	1737 663
GO TO 1500	1738 663
1280 CALL UNCHKE	1739 663
*HAS CHOKE ADJ COUNTER LIMIT BEEN EXCEEDED FOR SINGLE	1740 663
* WT FLOW	1741 663
IF(SENSE LIGHT 2)1505,1290	1742 663
1290 CONTINUE	1743 663
CALL SETYLD(ITRY,YIELD2)	1744 663
*TEST IF GOAL REACHABLE WITH TRY2 FROM UNCHKE	1745 663
IF(KOPT-2)1300,1300,1320	1746 663
*WALL TEMP	1747 663
1300 TEST1=YIELD2-GOAL	1748 663
IF(ABSF(TEST1) ACCTMP)1600,1600,1310	1749 663
1310 IF(TEST1)1344,1600,1340	1750 663
*PRES	1751 663
1320 TEST1=GOAL-YIELD2	1752 663
IF(ABSF(TEST1/GOAL)-SVACPR)1600,1600,1330	1753 663
1330 IF(TEST1)1340,1600,1344	1754 663
*SEE IF UNCHKE CAN MAKE FURTHER ADJUSTMENT	1755 663
1340 IF(KDI-1)1339,1344,1339	1756 663
1339 IF((WHI-WLO)/WHI-1.E-6)1342,1342,1341	1757 663
1341 OMAX1=(.9+OMAX1)/2.	1758 663
GO TO 1280	1759 663
*NEG OR ZERO IS FAILURE	1760 663

1342 LOC=2	1761 663
GO TO 1500	1762 663
*UPDATE TOTAL CHOKES COUNTER	1763 663
1344 KTCHTO=KTCHTO+KTCHAD	1764 663
T2=BSO(KDI)	1765 663
IF(ITRY-2)1346,1347,1348	1766 663
1346 TRY0=BSO(KDI)	1767 663
GO TO 1353	1768 663
1347 TRY1=BSO(KDI)	1769 663
GO TO 1353	1770 663
1348 TRY2=BSO(KDI)	1771 663
GO TO 1353	1772 663
* CHECK NEED FOR WALL TEMP CALC	1773 663
13500 IF(KOPT-2)13502,13502,13501	1774 663
13501 IF(KOPTH)13502,1350,1350	1775 663
13502 CALL TWLT(0)	1776 663
*DID STAGE EXIT WALL TEMP FAIL TO CONVERGE	1777 663
IF(SENSE LIGHT2) 1505,13504	1778 663
13504 IF(NSKPPR)1600,1350,1600	1779 663
*	1780 663
*NORMAL SEQUENCE AFTER NO CHOKE	1781 663
*TEST IF ITERATING	1782 663
1350 IF(KOPTH)1600,1352,1352	1783 663
1352 CALL SETYLD(ITRY,YIELD2)	1784 663
1353 TEST2=GOAL-YIELD2	1785 663
*TEST CONVERGENCE	1786 663
CALL FPRNT(6HYLD0-2,YIELD0,ITRY,3,KCHK1)	1787 663
IF(KOPT-2)1356,1356,1354	1788 663
*PRES	1789 663
1354 TEST2=TEST2/GOAL	1790 663
1356 TEST1=ABSF(TEST2)	1791 663
*START BOUND TEST SEQUENCE	1792 663
IF(TEST2)1363,1600,1358	1793 663
*HAS PLUS BOUND BEEN SET	1794 663
1358 IF(TESTOP)1361,1359,1361	1795 663
*SET PLUS BOUND	1796 663
1359 TESTP=TEST2	1797 663
TRYP=T2	1798 663
GO TO 1368	1799 663
*TEST PLUS BOUND	1800 663
1361 IF(TESTOP-TEST2)1368,1368,1359	1801 663
*HAS NEGATIVE BOUND BEEN SET	1802 663
1363 IF(TESTM)1366,1364,1366	1803 663
*SET NEGATIVE BOUND	1804 663
1364 TESTM=TEST2	1805 663
TRYM=T2	1806 663
GO TO 1368	1807 663
*TEST NEGATIVE BOUND	1808 663
1366 IF(TESTM-TEST2)1368,1368,1364	1809 663
*TEST IF MAX-MIN CAN BE SET	1810 663
1368 IF(TESTM*TESTOP)1370,1380,1370	1811 663
*SET MAX-MIN	1812 663
1370 TRYMAX=MAX1F(TRYM,TRYP)	1813 663
TRYMIN=MIN1F(TRYM,TRYP)	1814 663
CALL FPRNT(6HTRYMAX,TRYMAX,ITRY,1,KCHK1)	1815 663
CALL FPRNT(6HTRYMIN,TRYMIN,ITRY,1,KCHK1)	1816 663
194	1817 663

1380 CONTINUE	1818 66
CALL FPRNT(5HTEST2,TEST2,ITRY,1,KCHK1)	1819 66
CALL FPRNT(6HTSTGRP,TSTGRP,ITRY,4,KCHK1)	1820 66
IF(TEST1-DMCONV)1510,1510,1390	1821 66
*NOT CONVERGED - TEST COUNTER LIMIT	1822 66
1390 IF(LIMTRY-ITRY)1392,1395,1395	1823 66
*NEG FAILED	1824 66
1392 NT=170	1825 66
LOC=1	1826 66
GO TO 1500	1827 66
*CHECK FOR OSCILLATION	1828 66
1395 IF(TEST1-3.*DMCONV)1400,1400,1415	1829 66
*STEP OSCILLATION COUNTER	1830 66
1400 KOSCIL=KOSCIL+1	1831 66
IF(4 KOSCIL)1405,1405,1420	1832 66
*TIGHTEN CALC TOLERANCES	1833 66
1405 IF(4.*ACCPRS-SVACPR)1406,1406,1410	1834 66
*NEG OR ZERO IS FAILURE	1835 66
1406 NT=170	1836 66
LOC=2	1837 66
GO TO 1500	1838 66
1410 ACCPRS=.5*ACCPRS	1839 66
ACCMNO=.5*ACCMNO	1840 66
*NORMAL CONTINUATION	1841 66
1415 KOSCIL=0	1842 66
*STEP ITERATION COUNTER	1843 66
1420 ITRY=ITRY+1	1844 66
*IS THIS FIRST ITERATION	1845 66
IF(ITRY-3)1430,1480,1490	1846 66
*	1847 66
*FIRST ITERATION	1848 66
1430 YIELD0=YIELD2	1849 66
IF(KOPT-2)1432,1432,1434	1850 66
*TWMAX	1851 66
1432 TRY3=TRY0*(YIELD0/GOAL)**1.25	1852 66
GO TO 1445	1853 66
*PRES	1854 66
1434 IF(6 KOPT)1438,1436,1436	1855 66
*INLET PRESS IS FIXED	1856 66
1436 TRY3=TRY0*((PIND-GOAL)/(PIND-BSO(KDD)))*1.25	1857 66
GO TO 1445	1858 66
1438 TRY3=TRY0*GOAL/BSO(KDD)	1859 66
*AN EXIT PRESS IS FIXED	1860 66
*SET FOR NEXT CALL DPFRLT	1861 66
1445 T1=TRY0	1862 66
1448 T2=TRY3	1863 66
*HAVE MAX-MIN BEEN ESTABLISHED	1864 66
IF(TRYMAX*TRYMIN)1456,1449,1456	1865 66
*TEST TO INSURE NO NEGATIVE ITRY AND NOT EXCEED CHOKE LIMIT	1866 66
1449 IF(T2)1450,1450,1451	1867 66
1450 T2=.1*T1	1868 66
GO TO 1466	1869 66
1451 IF(WHI-T2)1452,1452,1466	1870 66
1452 T1=T1+.9*(WHI-T1)	1871 66
GO TO 1466	1872 66
*DELETE 1873-1874	1873 66
*TEST FOR T2 BETWEEN MAX AND MIN	1874 66

1456 IF(T2-TRYMIN)1460,1460,1458	1875 663
1458 IF(TRYMAX-T2)1460,1460,1466	1876 663
1460 T2=(TRYMAX+TRYMIN)/2.	1877 663
*FINISH PROCESSING	1878 663
1466 BSO(KDI)=T2	1879 663
IF(ITRY-3)1467,1468,1468	1880 663
1467 TRY1=T2	1881 663
GO TO 1469	1882 663
1468 TRY2=T2	1883 663
1469 KRT=2	1884 663
GO TO 1149	1885 663
1476 CONTINUE	1886 663
CALL FPRNT(6HTRY0-3,TRY0,ITRY,4,KCHK1)	1887 663
CALL FPRNT(3HBSO,BSO,ITRY,8,KCHK1)	1888 663
*TEST FOR PULL ON TIME	1889 663
IF(SENSE SWITCH 4)1478,1251	1890 663
1478 NT=999	1891 663
LOC=1	1892 663
GO TO 1500	1893 663
*	1894 663
*	1895 663
*SECOND ITERATION	1896 663
1480 YIELD1=YIELD2	1897 663
CALL EXTRAP(0,0,TRY0,YIELD0,TRY1,YIELD1,TRY3,	1898 663
1GOAL,2)	1899 663
1485 T1=TRY1	1900 663
GO TO 1448	1901 663
*	1902 663
*THIRD ITERATION	1903 663
1490 CALL EXTRAP(TRY0,YIELD0,TRY1,YIELD1,TRY2,YIELD2,	1904 663
1TRY3,GOAL,3)	1905 663
TRY0=TRY1	1906 663
TRY1=TRY2	1907 663
TRY2=TRY3	1908 663
YIELD0=YIELD1	1909 663
YIELD1=YIELD2	1910 663
GO TO 1485	1911 663
*END OF ITERATION SECTION	1912 663
*	1913 663
*ERROR COMMENT FOR ITERATION FAILURE	1914 663
1500 CALL NETERR(NT,LOC)	1915 663
1505 SENSE LIGHT 2	1916 663
1510 IF(KOPT-2)1600,1600,1520	1917 663
1520 CALL TWLT(0)	1918 663
*	1919 663
*SET UP MAJOR OUTPUT	1920 663
1600 CALL SETYLD(0,YIELD2)	1921 663
1604 IF(SENSE LIGHT 2)1601,1605	1922 663
1601 SENSE LIGHT 2	1923 663
GO TO 1700	1924 663
*SUCCESSFUL COMPLETION	1925 663
1605 KALCNO=KALCNO+1	1926 663
*MAKE ENTRIES IN SUMMARY TABLES	1927 663
KSVTAB(1,KALCNO)=KASE	1928 663
KSVTAB(13,KALCNO)=NHOT	1929 663
DO 1610 L=1,11	1930 663
1610 SAVTAB(L+1,KALCNO)=BSO(L)	1931 663

*	1932	663
*FINISHED	1933	663
1700 CONTINUE	1934	663
KTCHAD=0	1935	663
ACCMNO=SVACMN	1936	663
ACCPRS=SVACPR	1937	663
RETURN	1938	663
END(0,0,0)	1939	663
* * * * *	1940	663
*OUTPUT SR FOR SINGLE-CASE OUTPUT FOR	1941	663
*GFP 663 GENERAL FLOW PASSAGE	1942	663
* S C SKIRVIN	1943	663
*	1944	663
SUBROUTINE OUTPUT	1945	663
*	1946	663
*BEGIN STORAGE MAP	1947	663
*GENERAL USEAGE	1948	663
DIMENSION	1949	663
1AFFI (100),BSI (11),BSO (11),CLOSSI(100),CLSGEN(100),	1950	663
2CLSMOI(100),DHI (100),DPARAM(8),DPARMI(8),FMULTI(100),	1951	663
3FTABI (8),FPARMI(8),HTABI (6),HMULTI(100),KRSCON(4),	1952	663
4KPARAM(8),KPARMR(8),NDH (100),NAFL (100),NLEN (100),	1953	663
5NCLOSS(100),NCLSMO(100),NRINGD(100),NHMULT(100),NFMULT(100),	1954	663
6OLENI (100),PHISUM(100),PHIEX (100),PO (100),P1 (100),	1955	663
7P2 (100),THICKD(100),TEXI (100),XOLD (100),BHIGH (12),	1956	663
8HEDDUM(12),GMASS (100),TW (100),REYNO (100),FRIC (100),	1957	663
9CONVEC(100),DPINT(100),OMEXI(100),PRTGAS(9)	1958	663
DIMENSION PSEXI(100),PDYEXI(100),PEXI(100)	1959	663
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP	1960	663
EQUIVALENCE	1961	663
1(AD ,BG0(1)),(ACCMNO,BG0(2)),(ACCPRS,BG0(3)),	1962	663
2(ACCTMP,BG0(4)),(ALLRUN,BG0(5)),(AUTOLS,BG0(6)),	1963	663
3(BD ,BG0(7)),(BLANKS,BG0(8)),(BETA1 ,BG0(9)),	1964	663
4(BETA2 ,BG0(10)),(CIN ,BG0(11)),(CEX ,BG0(12)),	1965	663
5(DEAD ,BG0(13)),(DELH ,BG0(14)),(DERIV ,BG0(15)),	1966	663
6(ENTRN ,BG0(16)),(ENTRNC,BG0(17)),(FD ,BG0(18)),	1967	663
7(FTIN ,BG0(19)),(FTOUT ,BG0(20)),(FSTPAR,BG0(21)),	1968	663
8(GOAL ,BG0(22)),(GAS ,BG0(23)),(HIN ,BG0(24)),	1969	663
9(ITRY ,BG0(25)),(KTRCRD,BG0(26)),(KALCNO,BG0(27))	1970	663
EQUIVALENCE	1971	663
1(KTCHAD,BG0(28)),(KTWADJ,BG0(29)),(KTCHTO,BG0(30)),	1972	663
2(KPOW ,BG0(31)),(KOPT ,BG0(32)),(KOSCIL,BG0(33)),	1973	663
3(KCHOKE,BG0(34)),(KASE ,BG0(35)),(KASTEP,BG0(36)),	1974	663
4(LOC ,BG0(37)),(LIMCHK,BG0(38)),(LMCHTO,BG0(39)),	1975	663
5(LIMTRY,BG0(40)),(MORCAS,BG0(41)),(NSKPPR,BG0(42)),	1976	663
6(NSKPHT,BG0(43)),(NT ,BG0(44)),(NHOT ,BG0(45)),	1977	663
7(NOPRT ,BG0(46)),(NOSTGE,BG0(47)),(PARPRT,BG0(48)),	1978	663
8(PRTSUM,BG0(49)),(RNKIN ,BG0(50)),(RNKOUT,BG0(51)),	1979	663
9(SVACMN,BG0(52)),(SVACPR,BG0(53)),(TOTLND,BG0(54))	1980	663
EQUIVALENCE	1981	663
1(TRY0 ,BG0(55)),(TRY1 ,BG0(56)),(TRY2 ,BG0(57)),	1982	663
2(TRY3 ,BG0(58)),(TEST1 ,BG0(59)),(TOTLEN,BG0(60)),	1983	663
3(WHI ,BG0(61)),(WLO ,BG0(62)),(YIELD0,BG0(63)),	1984	663
4(YIELD1,BG0(64)),(YIELD2,BG0(65)),(NOINPT,BG0(66)),	1985	663
5(LIMPRS,BG0(67)),(PRTALL,BG0(68)),(OMAXD ,BG0(69)),	1986	663
6(OMAX,BG0(70)),(OMAX1,BG0(71)),(KOPHT,BG0(72)),	1987	663
7(DMCONV,BG0(75)),(KDI,BG0(76)),(KDD,BG0(77)),(TRYMAX,BG0(1988	1988	663

878)), (MAXTMP, BG0(79)), (LMBULK, BG0(80)), (TBBULK, BG0(81)),	1989 663
9(KCHK1, BG0(1)), (KCHK2, BG0(7)), (KCHK3, BG0(18)), (KGAS, BG0(82))	1990 663
EQUIVALENCE(PDYIN, BG0(73)), (PDYEX, BG0(74)), (OMINLT, BG0(83)),	1991 663
1(OMEXIT, BG0(84)), (DPIN, BG0(85)), (DPEX, BG0(86))	1992 663
2, (TRANSF, BG0(87)), (TRANHL, BG0(88)), (TRANHU, BG0(89))	1993 663
3, (NEWSET, BG0(90)), (KTPAR, BG0(91)), (KTOTPR, BG0(92)), (QBAR, BG0(93)),	1994 663
4(QOQBAR, BG0(94)), (NOGEOM, BG0(95))	1995 663
EQUIVALENCE	1996 663
1(AFFJ ,BG1(2)), (AFFI ,BG1(102)), (BSI ,BG1(202)),	1997 663
2(BSO ,BG1(213)), (BHIGH ,BG1(224)), (CLOSSI, BG1(237)),	1998 663
3(CLSGEN, BG1(337)), (CLSM DI, BG1(438)), (DHD ,BG1(539)),	1999 663
4(DHI ,BG1(639)), (DPARAM, BG1(739)), (DPARMI, BG1(747)),	2000 663
5(FTABI ,BG1(755)), (FPARMI, BG1(759)), (FMULTI, BG1(768)),	2001 663
6(GMASS ,BG1(868)), (HTABI ,BG1(968)), (HEDDUM, BG1(974)),	2002 663
7(HMULTI, BG1(987)), (KPARAM, BG1(1087)), (KPARMR, BG1(1095)),	2003 663
8(KRSCON, BG1(1103)), (NDH ,BG1(1107)), (NAFL ,BG1(1207)),	2004 663
9(NLEN ,BG1(1307)), (NCLOSS, BG1(1407)), (NCLSM D, BG1(1507))	2005 663
EQUIVALENCE	2006 663
1(NHMULT, BG1(1607)), (NFMULT, BG1(1707)), (OLEND ,BG1(1808)),	2007 663
2(OLENI ,BG1(1908)), (PHISUM, BG1(2008)), (PHIEX ,BG1(2108)),	2008 663
3(P0 ,BG1(2208)), (P1 ,BG1(2308)), (P2 ,BG1(2408)),	2009 663
4(TEXI ,BG1(2508)), (TW ,BG1(2608)), (XOLD ,BG1(2708)),	2010 663
5(XOL ,BG1(2808)), (REYNO ,BG1(2908)), (FRIC ,BG1(3008)),	2011 663
6(CONVEC, BG1(3108)), (DPINT, BG1(3208)), (OMEXI, BG1(3308))	2012 663
7, (PRTGAS, BG1(3408)), (PSEXI, BG1(3417)), (PDYEXI, BG1(3517))	2013 663
*OPEN AT 3617, KEEP OPEN UNTIL 3700	2014 663
DIMENSION KONOPT(2,10), KONPAR(4,13), SAVTAB(13,100), KSVTAB(13,100)	2015 663
EQUIVALENCE(KONOPT, KUP, BG2), (KONPAR, BG2(21)),	2016 663
1(SAVTAB, KSVTAB, BG2(73))	2017 663
*OPEN 1373	2018 663
EQUIVALENCE(THICKD, BG3(2)), (NRINGD, BG3(103)), (PEXI, BG3(203))	2019 663
*	2020 663
EQUIVALENCE(COFFLM, FTABI), (EXPFLM, FTABI(2)), (COFFTB,	2021 663
1FTABI(3)), (EXPFTB, FTABI(4))	2022 663
*	2023 663
*BASIC OPTIONAL VARIABLES	2024 663
DIMENSION GRTMPI(3), GRTMPO(3)	2025 663
EQUIVALENCE(PIN, BSI), (TIN, BSI(2)), (TEX, BSI(3)), (TWMAX,	2026 663
1BSI(4)), (PSEX, BSI(5)), (PEX, BSI(6)), (W, BSI(7)), (QTOT,	2027 663
2BSI(8)), (PIND, BSO), (TIND, BSO(2)), (TEXD, BSO(3)), (TWMAXD,	2028 663
3BSO(4)), (PSEX D, BSO(5)), (PEXD, BSO(6)), (WD, BSO(7)), (QTOTD,	2029 663
4BSO(8)), (PSXOP I, BSI(9)), (PTXOP I, BSI(10)), (TEXOTI, BSI(11)),	2030 663
5(PSPID, BSO(9)), (PTPID, BSO(10)), (TXTID, BSO(11)),	2031 663
6(GRTMPI, BSI(2)), (GRTMPO, BSO(2))	2032 663
*	2033 663
EQUIVALENCE(COFHLM, HTABI), (EXHPLM, HTABI(2)), (EXHRLM,	2034 663
1HTABI(3)), (COFHTB, HTABI(4)), (EXHPTB, HTABI(5)), (EXHRTB,	2035 663
2HTABI(6))	2036 663
EQUIVALENCE(DPTIN, DPARAM), (DTTIN, DPARAM(2)), (DTTEX, DPARAM(3)),	2037 663
1(DTWMAX, DPARAM(4)), (DPSEX, DPARAM(5)), (DPTEX, DPARAM(6)), (DW, DPARAM	2038 663
27)), (DQTOT, DPARAM(8)), (NOPTIN, KPARAM),	2039 663
3(NOTTIN, KPARAM(2)), (NOTTEX, KPARAM(3)), (NOTWMX, NTWMAX, NOTWA,	2040 663
4KPARAM(4)), (NOPSEX, KPARAM(5)), (NOPTEX, KPARAM(6)), (NOW, KPARAM(7)),	2041 663
5(NOQTOT, KPARAM(8))	2042 663
*	2043 663
* * * MASTER GROUPING	2044 663
DIMENSION BG0(100), BG1(2700), BG2(1272), BG3(202),	2045 663

1BG(5474)	2046	66
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	2047	66
COMMON BG	2048	66
* * * END OF MASTER GROUPING	2049	66
*	2050	66
*END OF STORAGE MAP	2051	66
*	2052	66
NOSTGE=NOSTGE	2053	66
KGAS=GAS	2054	66
REYNIN=GMASS(1)*DHI(1)*12./VISC(TIND,GAS)	2055	66
REYNEX=GMASS(NOSTGE)*DHI(NOSTGE)*12./VISC(TEXD,GAS)	2055A	66
*IS THIS A PARAMETRIC STUDY	2056	66
IF(MORCAS)104,104,95	2057	66
*IS THIS FIRST CASE FOR PARAM STUDY	2058	66
95 IF(FSTPAR)100,100,104	2059	66
*IS PARTIAL PRINT BEING USED	2060	66
100 IF(PARPR)104,104,105	2061	66
104 KTLIN=0	2062	66
*SET UNITS LENGTH	2063	66
105 KD1=1	2064	66
*SET UP STATIC PRESSURES IF NEEDED	2065	66
IF(PRTALL)106,109,106	2066	66
106 DO 107 N=1,NOSTGE	2067	66
107 PSEXI(N)=PSTAT(PEXI(N),TEXI(N),OMEXI(N),GAS)	2068	66
IF(DPINT(NOSTGE))108,109,108	2069	66
108 PSEXI(NOSTGE)=PSTAT(PEXI(NOSTGE)-DPINT(NOSTGE),	2070	66
1TEXI(NOSTGE),OMEXI(NOSTGE),GAS)	2071	66
109 CONTINUE	2072	66
IF(FTOUT)120,120,110	2073	66
110 KD1=2	2074	66
*TEMP	2075	66
120 KD2=1	2076	66
IF(RNKOUT)140,140,130	2077	66
130 KD2=2	2078	66
140 KRT=1	2079	66
IF(MORCAS)150,150,142	2080	66
142 IF(FSTPAR)144,144,150	2081	66
144 IF(PARPR)150,150,160	2082	66
*UNIT HEADING	2083	66
150 CALL PRUNT(2,KD1,KD2)	2084	66
GO TO(160,222,243,275,280,245),KRT	2085	66
*CHECK NEED FOR UNIT CHANGING	2086	66
160 IF(FTOUT)200,200,170	2087	66
*FEET FOR OUTPUT, ALSO USED FOR RESET IN PARAMETRIC	2088	66
170 TRAN2=.00694444	2089	66
KRT1=0	2090	66
180 IF(PARPR)185,185,195	2091	66
185 DO 190 N=1,NOSTGE	2092	66
GMASS(N)=GMASS(N)/TRAN2	2093	66
PDYEXI(N)=PDYEXI(N)/TRAN2	2094	66
DPINT(N)=DPINT(N)/TRAN2	2095	66
PEXI(N)=PEXI(N)/TRAN2	2096	66
PSEXI(N)=PSEXI(N)/TRAN2	2097	66
CONVEC(N)=CONVEC(N)/TRAN2	2098	66
190 CONTINUE	2099	66
PDYIN=PDYIN/TRAN2	2100	66
PDYEX=PDYEX/TRAN2	2101	66

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        DPIN=DPIN/TRAN2
        DPEX=DPEX/TRAN2
195    PEXD=PEXD/TRAN2
        PIND=PIND/TRAN2
        PSEX=D=PEXD/TRAN2
        IF(KRT1)200,200,350
*TEMP
200    CONTINUE
        IF(RNKOUT)210,210,211
*DEG F IN OUTPUT
210    CALL CONTMP(GRTMPO,3,GRTMPO,-1)
        CALL CONTMP(TEXI,NOSTGE,TEXI,-1)
        CALL CONTMP(TW,NOSTGE,TW,-1)
*BASIC OUTPUT
211    PIMPX=PIND-PEXD
        TIMTX=TIND-TEXD
*IS CHOKE COMMENT NEEDED
        IF(KCHOKE)212,213,212
212    KTLINE=KTLINE+5
        PRINT 32005,KCHOKE
32005    FORMAT
        SPACE
        * * * * *
        * CHOKE OCURRED IN STAGE -I. IGNORE *
        * ALL RESULTS THERE AND DOWNSTREAM. *
        * * * * *
        END OF FORMAT
*
213    KTLINE=KTLINE+19
        IF(50-KTLINE)221,222,222
221    KRT=2
        KTLINE=21
        GO TO 150
222    CONTINUE
        PRINT 32010,KASE,PRTGAS(KGAS),KGAS,WD,TWMAXD,NHOT,
1QTOTD,PIND,TIND,PDYIN,OMINLT,REYNIN,PEXD,PSEXD,
2TEXD,PDYEX,OMEXIT,REYNEX,PIMPX,TIMTX,PTPID,
3TXTID,PSPID
32010    FORMAT
        SPACE
CASE    -I          FLOW AND TEMPERATURE RESULTS (GAS IS-X    -A, NO -I)
        SPACE
WEIGHT FLOW =          -1PE5    MAX AVE WALL TEMP =    -OPF2 AT STAGE -I
        HEAT ADDITION =          -1PE4
        SPACE
TOTAL    STATIC    TOTAL    DYNAMIC    MACH    REYNOLDS
PRESS    PRESS    TEMP    PRESS    NO    NO
SPACE
INLET    -OPF3          -F1    -1PE4    -OPF4    -1PE5
EXIT      -OPF3          -F3    -F1    -1PE4    -OPF4    -1PE5
IN-EX     -E4          -OPF2
RATIO     -F5          -F4    PSEX/PTIN =    -F5
        END OF FORMAT
*
*IS ENTRANCE OR EXIT LOSS PRINTOUT REQUIRED
        IF(CIN)230,225,230
225    IF(CEX)220,225,220

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230 PIMDP=PIND-DPIN	2159 663
PRINT 32015,CIN,DPIN,PIMDP,CEX,DPEX,PEXI(NOSTGE)	2160 663
32015 FORMAT	2161 663
SPACE 2	2162 663
ENTRANCE AND EXIT LOSSES	2163 663
LOSS COEFF P-TOT LOSS TOT PRESS	2164 663
INLET -1PE4 -E4 -OPF3(AFTER)	2165 663
EXIT -1PE4 -E4 -OPF3(BEFORE)	2166 663
END OF FORMAT	2167 663
*	2168 663
GO TO 240	2169 663
235 KTLINE=KTLINE-7	2170 663
*IS NORMAL STAGE-BY-STAGE PRINTOUT WANTED	2171 663
240 IF(PARPR)239,239,310	2172 663
239 IF(17-NOSTGE)242,241,241	2173 663
241 NL=1	2174 663
NU=NOSTGE	2175 663
EXIT=1.	2176 663
GO TO 245	2177 663
242 KRT=3	2178 663
NL=1	2179 663
NU=NOSTGE	2180 663
EXIT=1.	2181 663
GO TO 150	2182 663
243 IF(41-NOSTGE)244,245,245	2183 663
244 NU=41	2184 663
EXIT=0.	2185 663
*NORMAL STAGEWISE OUTPUT	2186 663
245 PRINT 32020,KASE,(N,PEXI(N),DPINT(N),TEXI(N),TW(N),	2187 663
1OMEXI(N),REYNO(N),N=NL,NU)	2188 663
32020 FORMAT	2189 663
SPACE 2	2190 663
CASE -I STAGE BY-STAGE OUTPUT RESULTS	2191 663
SPACE	2192 663
STGE EXIT INTRSTGE EXIT EXIT AVE	2193 663
P-TOT P TO LOSS T-TOT T-WALL MACH NO REYN NO	2194 663
SPACE	2195 663
-I -OPF3 -F5 -F1 -F1 -F4 -1PE5	2196 663
REPEAT 1	2197 663
END OF FORMAT	2198 663
*	2199 663
IF(EXIT)250,246,250	2200 663
246 NL=NU+1	2201 663
KRT=6	2202 663
IF(82-NOSTGE)247,248,248	2203 663
247 IF(82-NU)248,248,249	2204 663
248 NU=NOSTGE	2205 663
EXIT=1.	2206 663
GO TO 150	2207 663
249 NU=82	2208 663
GO TO 150	2209 663
*IS REMAINING STAGEWISE OUTPUT WANTED	2210 663
250 IF(PRTALL)310,310,260	2211 663
*REMAINING STAGEWISE OUTPUT	2212 663
260 KRT=4	2213 663
GO TO 150	2214 663
275 NL=1	2215 663

NU=NOSTGE	2216 663
IF(41-NOSTGE)276,280,280	2217 663
276 NU=41	2218 663
EXIT=0.	2219 663
280 PRINT 32025,KASE,(N,PDYEXI(N),PSEXI(N),CLSGEN(N),	2220 663
1CONVEC(N),FRIC(N),GMASS(N),N=NL,NU)	2221 663
32025 FORMAT	2222 663
SPACE 2	2223 663
CASE -I MISCELLANEOUS STAGE-BY-STAGE OUTPUT	2224 663
SPACE	2225 663
EXIT EXIT AUTO INTR- H- F- MASS	2226 663
STGE P-DYN P STAT STG COEFF COEFF FACTOR VELOCITY	2227 663
SPACE	2228 663
-I -1PE4 -OPF3 -F5 -1PE4 -E4 -E4	2229 663
REPEAT 1	2230 663
END OF FORMAT	2231 663
*	2232 663
IF(EXIT)310,285,310	2233 663
285 NL=NU+1	2234 663
KRT=5	2235 663
IF(82-NOSTGE)290,300,300	2236 663
290 IF(82-NU)300,300,295	2237 663
295 NU=82	2238 663
GO TO 150	2239 663
300 NU=NOSTGE	2240 663
EXIT=1.	2241 663
GO TO 150	2242 663
*CHECK IF PARAMETRIC REQUIRING UNIT RESET	2243 663
310 IF(MORCAS)350,350,315	2244 663
315 IF(RNKOUT)330,320,330	2245 663
320 CALL CONTMP(GRTMPO,3,GRTMPO,1)	2246 663
330 IF(FTOUT)350,350,340	2247 663
340 TRAN2=144.	2248 663
KRT2=1	2249 663
GO TO 195	2250 663
*SR FINISHED	2251 663
350 CONTINUE	2252 663
RETURN	2253 663
END(0,0,0)	2254 663
* * * * *	2255 663
*PRTUNT63 SR TO PRINT UNIT HEADING FOR	2256 663
SUBROUTINE PRTUNT(KD1,KD2,KD3)	2257 663
DIMENSION BHIGH(12),BWHEN(2),BUNLEN(4,2),BUNTMP(2)	2258 663
EQUIVALENCE(BHIGH,BG1(224)),(BWHEN,BHIGH),(BUNLEN,	2259 663
1BHIGH(3)),(BUNTMP,BHIGH(11))	2260 663
* * * MASTER GROUPING	2261 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	2262 663
1BG(5474)	2263 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801))	2264 663
COMMON BG	2265 663
* * * END OF MASTER GROUPING	2266 663
K1=KD1	2267 663
K2=KD2	2268 663
K3=KD3	2269 663
WRITE OUTPUT TAPE 3,32750,BWHEN(K1),(BUNLEN(L,K2),	2270 663
1L=1,4),BUNTMP(K3)	2271 663
32750 FORMAT	2272 663

RESTORE	2273	663
SPACE	2274	663
*** GENERAL FLOW PASSAGE (ANP 663) ***	2275	663
-X -A UNITS ARE-X -A -A BTU/SEC, LBM/SEC.	2276	663
END OF FORMAT	2277	663
*	2278	663
RETURN	2279	663
END(0,0,0)	2280	663
* * * * *	2281	663
*READIN DATA LOADING AND PARAMETRIC STUDY CONTROL FOR	2282	663
* GENERAL FLOW PASSAGE (ANP 663)	2283	663
*	2284	663
SUBROUTINE READIN	2285	663
*	2286	663
*BEGIN STORAGE MAP	2287	663
*GENERAL USEAGE	2288	663
DIMENSION	2289	663
1AFFI (100),BSI (11),BSO (11),CLOSSI(100),CLSGEN(100),	2290	663
2CLSMDI(100),DHI (100),DPARAM(8),DPARMI(8),FMULTI(100),	2291	663
3FTABI (8),FPARMI(8),HTABI (6),HMULTI(100),KRSCON(4),	2292	663
4KPARAM(8),KPARMR(8),NDH (100),NAFL (100),NLEN (100),	2293	663
5NCLOSS(100),NCLSM(100),NRINGD(100),NHMULT(100),NFMULT(100),	2294	663
6OLENI (100),PHISUM(100),PHIEX (100),PO (100),P1 (100),	2295	663
7P2 (100),THICKD(100),TEXI (100),XOLD (100),BHIGH (12),	2296	663
8HEDDUM(12),GMASS (100),JW (100),REYNO (100),FRIC (100),	2297	663
9CONVEC(100),DPINT(100),OMEXI(100),PRTGAS(9)	2298	663
DIMENSION PSEXI(100),PDYEXI(100),PEXI(100)	2299	663
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP	2300	663
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE	2301	663
EQUIVALENCE	2302	663
1(AD ,BG0(1)),(ACCMNO,BG0(2)),(ACCPRS,BG0(3)),	2303	663
2(ACCTMP,BG0(4)),(ALLRUN,BG0(5)),(AUTOLS,BG0(6)),	2304	663
3(BD ,BG0(7)),(BLANKS,BG0(8)),(BETA1 ,BG0(9)),	2305	663
4(BETA2 ,BG0(10)),(CIN ,BG0(11)),(CEX ,BG0(12)),	2306	663
5(DEAD ,BG0(13)),(DELH ,BG0(14)),(DERIV ,BG0(15)),	2307	663
6(ENTRN ,BG0(16)),(ENTRNC,BG0(17)),(FD ,BG0(18)),	2308	663
7(FTIN ,BG0(19)),(FTOUT ,BG0(20)),(FSTPAR,BG0(21)),	2309	663
8(GOAL ,BG0(22)),(GAS ,BG0(23)),(HIN ,BG0(24)),	2310	663
9(ITRY ,BG0(25)),(KTRCRD,BG0(26)),(KALCNO,BG0(27))	2311	663
EQUIVALENCE	2312	663
1(KTCHAD,BG0(28)),(KTWADJ,BG0(29)),(KTCHTO,BG0(30)),	2313	663
2(KPOW ,BG0(31)),(KOPT ,BG0(32)),(KOSCIL,BG0(33)),	2314	663
3(KCHOKO,BG0(34)),(KASE ,BG0(35)),(KASTEP,BG0(36)),	2315	663
4(LOC ,BG0(37)),(LIMCHK,BG0(38)),(LMCHTO,BG0(39)),	2316	663
5(LIMTRY,BG0(40)),(MORCAS,BG0(41)),(NSKPPR,BG0(42)),	2317	663
6(NSKPHT,BG0(43)),(NT ,BG0(44)),(NHOT ,BG0(45)),	2318	663
7(NOPRT ,BG0(46)),(NOSTGE,BG0(47)),(PARPRT,BG0(48)),	2319	663
8(PRTSUM,BG0(49)),(RNKIN ,BG0(50)),(RNKOUT,BG0(51)),	2320	663
9(SVACMN,BG0(52)),(SVACPR,BG0(53)),(TOTLND,BG0(54))	2321	663
EQUIVALENCE	2322	663
1(TRY0 ,BG0(55)),(TRY1 ,BG0(56)),(TRY2 ,BG0(57)),	2323	663
2(TRY3 ,BG0(58)),(TEST1 ,BG0(59)),(TOTLEN,BG0(60)),	2324	663
3(WHI ,BG0(61)),(WLO ,BG0(62)),(YIELD0,BG0(63)),	2325	663
4(YIELD1,BG0(64)),(YIELD2,BG0(65)),(NOINPT,BG0(66)),	2326	663
5(LIMPRS,BG0(67)),(PRTALL,BG0(68)),(OMAXD ,BG0(69)),	2327	663
6(OMAX,BG0(70)),(OMAX1,BG0(71)),(KOPHT,BG0(72)),	2328	663
7. (DMCONV,BG0(75)),(KD+,BG0(76)),(TUKDD,BG0(77))-3-		

878)), (MAXTMP, BG0(79)), (LMBULK, BG0(80)), (TBBULK, BG0(81)),	2330	663
9(KCHK1, BG0(1)), (KCHK2, BG0(7)), (KCHK3, BG0(18)), (KGAS, BG0(82))	2331	663
EQUIVALENCE(PDYIN, BG0(73)), (PDYEX, BG0(74)), (OMINLT, BG0(83)),	2332	663
1(OMEXIT, BG0(84)), (DPIN, BG0(85)), (DPEX, BG0(86))	2333	663
2, (TRANSF, BG0(87)), (TRANHL, BG0(88)), (TRANHU, BG0(89))	2334	663
3, (NEWSET, BG0(90)), (KTPAR, BG0(91)), (KTOTPR, BG0(92)), (QBAR, BG0(93)),	2335	663
4(QOQBAR, BG0(94)), (NOGEOM, BG0(95))	2336	663
EQUIVALENCE	2337	663
1(AFFD, BG1(2)), (AFFI, BG1(102)), (BSI, BG1(202)),	2338	663
2(BSO, BG1(213)), (BHIGH, BG1(224)), (CLOSSI, BG1(237)),	2339	663
3(CLSGEN, BG1(337)), (CLSM DI, BG1(438)), (DHD, BG1(539)),	2340	663
4(DHI, BG1(639)), (DPARAM, BG1(739)), (DPARM I, BG1(747)),	2341	663
5(FTABI, BG1(755)), (FPARM I, BG1(759)), (FMULTI, BG1(768)),	2342	663
6(GMASS, BG1(868)), (HTABI, BG1(968)), (HEDDUM, BG1(974)),	2343	663
7(HMULTI, BG1(987)), (KPARAM, BG1(1087)), (KPARMR, BG1(1095)),	2344	663
8(KRSCON, BG1(1103)), (NDH, BG1(1107)), (NAFL, BG1(1207)),	2345	663
9(NLEN, BG1(1307)), (NCLOSS, BG1(1407)), (NCLSM D, BG1(1507))	2346	663
EQUIVALENCE	2347	663
1(NHMULT, BG1(1607)), (NFMULT, BG1(1707)), (OLEND, BG1(1808)),	2348	663
2(OLENI, BG1(1908)), (PHISUM, BG1(2008)), (PHIEX, BG1(2108)),	2349	663
3(P0, BG1(2208)), (P1, BG1(2308)), (P2, BG1(2408)),	2350	663
4(TEXI, BG1(2508)), (TW, BG1(2608)), (XOLD, BG1(2708)),	2351	663
5(XOL, BG1(2808)), (REYNO, BG1(2908)), (FRIC, BG1(3008)),	2352	663
6(CONVEC, BG1(3108)), (DPINT, BG1(3208)), (OMEXI, BG1(3308))	2353	663
7, (PRTGAS, BG1(3408)), (PSEXI, BG1(3417)), (PDYEXI, BG1(3517))	2354	663
*OPEN AT 3617, KEEP OPEN UNTIL 3700	2355	663
DIMENSION KONOPT(2,10), KONPAR(4,13), SAVTAB(13,100), KSVTAB(13,100)	2356	663
EQUIVALENCE(KONOPT, KUP, BG2), (KONPAR, BG2(21)),	2357	663
1(SAVTAB, KSVTAB, BG2(73))	2358	663
*OPEN 1373	2359	663
EQUIVALENCE(THICKD, BG3(2)), (NRINGD, BG3(103)), (PEXI, BG3(203))	2360	663
*	2361	663
EQUIVALENCE(COFFLM, FTABI), (EXPFLM, FTABI(2)), (COFFTB,	2362	663
1FTABI(3)), (EXPFTB, FTABI(4))	2363	663
*	2364	663
*BASIC OPTIONAL VARIABLES	2365	663
DIMENSION GRTMPI(3), GRTMPO(3)	2366	663
EQUIVALENCE(PIN, BSI), (TIN, BSI(2)), (TEX, BSI(3)), (TWMAX,	2367	663
1BSI(4)), (PSEX, BSI(5)), (PEX, BSI(6)), (W, BSI(7)), (QTOT,	2368	663
2BSI(8)), (PIND, BSO), (TIND, BSO(2)), (TEXD, BSO(3)), (TWMAXD,	2369	663
3BSO(4)), (PSEXD, BSO(5)), (PEXD, BSO(6)), (WD, BSO(7)), (QTOTD,	2370	663
4BSO(8)), (PSXOPI, BSI(9)), (PTXOPI, BSI(10)), (TEXOTI, BSI(11)),	2371	663
5(PSPID, BSO(9)), (PTPID, BSO(10)), (TXTID, BSO(11)),	2372	663
6(GRTMPI, BSI(2)), (GRTMPO, BSO(2))	2373	663
*	2374	663
EQUIVALENCE(COFHLM, HTABI), (EXHPLM, HTABI(2)), (EXHRLM,	2375	663
1HTABI(3)), (COFHTB, HTABI(4)), (EXHPTB, HTABI(5)), (EXHRTB,	2376	663
2HTABI(6))	2377	663
EQUIVALENCE(DPTIN, DPARAM), (DTTIN, DPARAM(2)), (DTTEX, DPARAM(3)),	2378	663
1(DTWMAX, DPARAM(4)), (DPSEX, DPARAM(5)), (DPTEX, DPARAM(6)), (DW, DPARAM(	2379	663
27)), (DQTOT, DPARAM(8)), (NOPTIN, KPARAM),	2380	663
3(NOTTIN, KPARAM(2)), (NOTTEX, KPARAM(3)), (NOTWMX, NTWMAX, NOTWA,	2381	663
4KPARAM(4)), (NOPSEX, KPARAM(5)), (NOPTEX, KPARAM(6)), (NOW, KPARAM(7)),	2382	663
5(NOQTOT, KPARAM(8))	2383	663
*LIMITED USAGE	2384	663
DIMENSION AFFD(100), DHD(100), OLEND(100), XOL(100)	2385	663
EQUIVALENCE(AFFD, AFF(2)), (CLOSSI, CLOSS(2)), (CLSM DI, CLSMOD(2)),	2386	663

1(DHD,DH(2)),(DH,DOUTER,ELPMAJ,WIDTH),(AFF,DINNER,ELPMIN,	2387	663
2HEIGHT),(FMULTI,FMULT(2)),(HMULTI,HMULT(2)),(ROUND,KRSCON),	2388	663
3(RECTNG,KRSCON(2)),(ELLIPS,KRSCON(3)),(RINGS,KRSCON(4)),	2389	663
4(OLEND,LENGTH(2)),(NRINGD,NORING(2)),(NAFF,NAFL),(THICKD,	2390	663
5THICK(2)),(PTIN,PIN),(TTIN,TIN),(PTEX,PEX),(TEX,TTEX),	2391	663
6(CASE,KASE),(CASTEP,KASTEP),(DHD,DHG),(DH,DHGSUB),(AFF,	2392	663
7AFFSUB),(OLEND,OL),(LENGTH,OLSUB),(ACCMNO,PER),(NOSTGE,MN),	2393	663
8(HTABI(4),A1),(FTABI(3),B1),(FTABI(4),OM),(FMULTI,AKF),(HMULTI,	2394	663
9AKH),(CIN,C1),(CEX,C2),(PHISUM,A2),(PHIEX,Q),(NLEN,NOL)	2395	663
EQUIVALENCE(NDH,NDHG),(MAXMNO,OMAXD)	2396	663
*ALL MODIFIED OFF-DESIGN(ANP 443) INPUT VARIABLES	2397	663
* ARE IN DIP LIST, FUNCTIONALLY WHEREVER POSSIBLE	2398	663
EQUIVALENCE(HEADER,HEDDUM(12))	2399	663
*FOR READIN ONLY	2400	663
*SPELLINGS, OFFSETS, ETC.	2401	663
DIMENSION	2402	663
1AFF (101),CLSMOD(101),CLOSS (101),DH (101),LENGTH(101),	2403	663
2NORING(101),THICK(101),FMULT(101),HMULT(101)	2404	663
EQUIVALENCE(NOSTGE,STAGES)	2405	663
*	2406	663
* * * MASTER GROUPING	2407	663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	2408	663
1BG(5474)	2409	663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	2410	663
COMMON BG	2411	663
* * * END OF MASTER GROUPING	2412	663
*	2413	663
*END OF STORAGE MAP	2414	663
*	2415	663
KOPT=KOPT	2416	663
DUMDIP=0.	2417	663
*IS PROGRAM IN PARAMETRIC LOOP	2418	663
IF(MORCAS)80,80,240	2419	663
80 IF(SENSE SWITCH 2)95,85	2420	663
*AVOIDS COMMENT CARD TROUBLE BY INSPECTING FIRST RECORD	2421	663
* OF TAPE 2	2422	663
85 CALL TPINSP	2423	663
*	2424	663
*LOAD DATA	2425	663
95 IF(DUMDIP)99,100,99	2426	663
99 READ DIP DHGSUB,AFFSUB,OL,OLSUB,PER,MN,A1,B1,OM,OK,AKF,AKH,AAF,AAF2	2427	663
12,CIN,CEX,C1,C2,TWT,A2,Q,FT,FTEMP,PSIINP,INOL,INDHG,INAAFL,INAAFL,	2428	663
2INAAFL2,PSIOUT,TQT,NOL,NDHG,DWADD,TBADD,PSIN,XNORM,PUNCH,PRINT,NW,W	2429	663
3SUB,KPOWER,INPUT,NOINPT,LIMPRS,PRTALL,MAXMNO,MAXTMP,LMBULK,TBBULK,	2430	663
4KCHK1,KCHK2,KCHK3,TRANSF,TRANHL,TRANHU,NEWSET,QBAR,QQBAR,NOGEOM	2431	663
5,STAGES	2432	663
100 READ DIP ACCMNO,ACCPRS,ACCTMP,ALLRUN,AUTOLS,AFF,BETA1,BETA2,CLOSS,	2433	663
1CLSMOD,DOUTE-TD+NNE-,DHTENT-*CTEL-MAJTEL		
2LT,HMULT,HEIGHT,KASE,KASTEP,LIMCHK,LMCHTO,LIMTRY,NDH,NAFF,NAFL,NLE	2435	663
3N,NCLOSS,NOPRT,NOSTGE,NCLSMO,NORING,NHMULT,NFMULT,LENGTH,PARPRT,PR	2436	663
4TSUM,PHISUM,PHIEX,PO,PO,P1,PI,P2,PTXOPI,PSXOPI,RNKIN,RNKOUT,ROUND,	2437	663
5RECTNG,RINGS,THICK,TOTLEN,TEXOTI,WIDTH,XOL,PEX,PTEX,PIN,PTIN,TIN,T	2438	663
6T+N,PSEXTTEXTTTEXTWTWMAOT-,OTT*	OK132	552
7NOQTOT,NOPSEXTNOPTX,NOWTNOTTEXTDPT+N,DTT+N		
8EX,DW,DTTEX,COFHLM,COFHTB,EXHPLM,EXHPTB,EXHRLM,EXHRTB,COFFLM,COFFT	2441	663
9B,EXPFLM,EXPFTB,CASE,CASTEP,PTXOPI,PSXOPI,TEXOTI,GAS,HEADER,DHG	2442	663
*	2443	663

KTRCRD=KTRCRD+1	2444 663
*WAS DIP ERROR ENCOUNTERED	2445 663
IF(SENSE LIGHT 1)120,130	2446 663
120 PRINT 32032,KTRCRD	2447 663
32032 FORMAT	2448 663
SPACE	2449 663
ABOVE DIP ERRORS OCCURRED IN INPUT RECORD NO -1.	2450 663
SPACE	2451 663
END OF FORMAT	2452 663
DEAD=1.	2453 663
GO TO 80	2454 663
*IS JOB BEING PULLED (YES IF SS4 DOWN)	2455 663
130 IF(SENSE SWITCH 4)100,135	2456 663
*NORMAL CONTINUATION WAS AN ERROR PREVIOUSLY ENCOUNTERED	2457 663
135 IF(DEAD)150,150,140	2458 663
*IS PROGRAM TO CALCULATE ANYWAY	2459 663
140 IF(ALLRUN)80,80,145	2460 663
*HAS A NEWSET CASE FAILED	2461 663
145 IF(SENSE LIGHT 4)146,147	2462 663
146 SENSE LIGHT 4	2463 663
GO TO 100	2464 663
147 DEAD=0.	2465 663
*CHECK STAGE LIMIT NOT EXCEEDED	2466 663
150 IF(100-NOSTGE)151,152,152	2467 663
151 DEAD=1.	2468 663
CALL NETERR(152,152)	2469 663
GO TO 80	2470 663
*NORMAL SEQUENCE - CHECK IF POSSIBLE PARAMETRIC	2471 663
152 DO 160 N=1,8	2472 663
IF(KPARAM(N))160,160,155	2473 663
*POSSIBLY PARAMETRIC	2474 663
155 MORCAS=1	2475 663
FSTPAR=1.	2476 663
KASESV=KASE	2477 663
KTPAR=0	2478 663
GO TO 165	2479 663
160 CONTINUE	2480 663
*NOT PARAMETRIC	2481 663
GO TO 360	2482 663
*PRE-PROCESSING FOR PARAMETRIC STUDIES	2483 663
*SET RUNNING COUNTERS	2484 663
165 DO 190 K=1,8	2485 663
IF(DPARAM(K))180,170,180	2486 663
170 KPARMR(K)=0	2487 663
GO TO 190	2488 663
180 KPARMR(K)=KPARAM(K)-1	2489 663
190 CONTINUE	2490 663
*CHECK NEED FOR UNIT CHANGES ON INCREMENTS	2491 663
* AFTER GENERAL TRANSFER	2492 663
DO 200 K=1,8	2493 663
200 DPARMI(K)=DPARAM(K)	2494 663
IF(FTIN)360,360,210	2495 663
210 DPARMI(1)=DPARMI(1)/144.	2496 663
DPARMI(5)=DPARMI(5)/144.	2497 663
DPARMI(6)=DPARMI(6)/144.	2498 663
GO TO 360	2499 663
*WAS CASE JUST COMPLETED FIRST PARAMETRIC CASE	2500 663

240 IF(FSTPAR)250,270,250	2501 66
*FIRST PARAMETRIC	2502 66
250 DO 260 K=1,8	2503 66
260 FPARMI(K)=BSO(K)	2504 66
FSTPAR=0.	2505 66
*NORMAL PARAMETRIC CONTROL - CHECK COUNTERS	2506 66
270 KASE=KASE+1	2507 66
DO 290 K=1,4	2508 66
K=K	2509 66
KD=KONPAR(K,KOPT)	2510 66
IF(KPARMR(KD))290,290,280	2511 66
*INCREMENT K-TH VARIABLE	2512 66
280 BSO(KD)=BSO(KD)+DPARM(1,KD)	2513 66
KPARMR(KD)=KPARMR(KD)-1	2514 66
GO TO 310	2515 66
290 CONTINUE	2516 66
*EXIT HERE MEANS PARAMETRIC STUDY FINISHED	2517 66
*RESTORE INPUT VALUES OF MAJOR VARIABLES	2518 66
DO 300 L=1,8	2519 66
300 BSO(L)=FPARMI(L)	2520 66
KASE=KASESV	2521 66
MORCAS=0	2522 66
CALL RESET	2523 66
*RETURN FOR NEW DATA	2524 66
GO TO 80	2525 66
*NORMAL SEQUENCING - RESET RIGHTWARD COUNTERS	2526 66
* AND VARIABLES	2527 66
310 KM1=K-1	2528 66
IF(KM1)360,360,320	2529 66
320 DO 350 L=1,KM1	2530 66
KD=KONPAR(L,KOPT)	2531 66
IF(DPARAM(KD))340,350,340	2532 66
340 KPARMR(KD)=KPARAM(KD)-1	2533 66
BSO(KD)=FPARMI(KD)	2534 66
350 CONTINUE	2535 66
*SR ALL FINISHED	2536 66
360 CONTINUE	2537 66
RETURN	2538 66
END(0,0,0)	2539 66
* * * * *	2540 66
*RESET663 RESETS CERTAIN CALCULATED DATA FIELDS FOR	2541 66
*GFP 663 GENERAL FLOW PASSAGE	2542 66
* S C SKIRVIN	2543 66
*	2544 66
SUBROUTINE RESET	2545 66
*	2546 66
*BEGIN STORAGE MAP	2547 66
*GENERAL USAGE	2548 66
DIMENSION	2549 66
1AFFI (100),BSI (11),BSO (11),CLOSSI(100),CLSGEN(100),	2550 66
2CLSMDI(100),DHI (100),DPARAM(8),DPARMI(8),FMULTI(100),	2551 66
3FTABI (8),FPARMI(8),HTABI (6),HMULTI(100),KRSCON(4),	2552 66
4KPARAM(8),KPARMR(8),NDH (100),NAFL (100),NLEN (100),	2553 66
5NCLCSS(100),NCLSMD(100),NRINGD(100),NHMULT(100),NFMULT(100),	2554 66
6OLENI (100),PHISUM(100),PHIEX (100),PO (100),P1 (100),	2555 66
7P2 (100),THICKD(100),TEXI (100),XOLD (100),BHIGH (12),	2556 66
8HEDDUM(12),GMASS (100),TW (100),REYNO (100),FRIC (100),	2557 66

9CONVEC(100),DPINT(100),OMEXI(100),PRTGAS(9)	2558 663
DIMENSION PSEXI(100),PDYEXI(100),PEXI(100)	2559 663
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP	2560 663
EQUIVALENCE	2561 663
1(KTCHAD,BG0(28)),(KTWADJ,BG0(29)),(KTCHTO,BG0(30)),	2562 663
2(KPOW ,BG0(31)),(KOPT ,BG0(32)),(KOSCIL,BG0(33)),	2563 663
3(KCHOKE,BG0(34)),(KASE ,BG0(35)),(KASTEP,BG0(36)),	2564 663
4(LOC ,BG0(37)),(LIMCHK,BG0(38)),(LMCHTO,BG0(39)),	2565 663
5(LIMTRY,BG0(40)),(MORCAS,BG0(41)),(NSKPPR,BG0(42)),	2566 663
6(NSKPTH,BG0(43)),(NT ,BG0(44)),(NHOT ,BG0(45)),	2567 663
7(NOPRT ,BG0(46)),(NOSTGE,BG0(47)),(PARPRT,BG0(48)),	2568 663
8(PRTSUM,BG0(49)),(RNKIN ,BG0(50)),(RNKOUT,BG0(51)),	2569 663
9(SVACMN,BG0(52)),(SVACPR,BG0(53)),(TOTLND,BG0(54)),	2570 663
EQUIVALENCE(PDYIN,BG0(73)),(PDYEX,BG0(74)),(OMINLT,BG0(83)),	2571 663
1(OMEXIT,BG0(84)),(DPIN,BG0(85)),(DPEX,BG0(86))	2572 663
2,(TRANSF,BG0(87)),(TRANHL,BG0(88)),(TRANHU,BG0(89))	2573 663
3,(NEWSET,BG0(90)),(KTPAR,BG0(91)),(KTOTPR,BG0(92)),(QBAR,BG0(93)),	2574 663
4(QOQBAR,BG0(94)),(NOGEOM,BG0(95))	2575 663
EQUIVALENCE	2576 663
1(AFFD ,BG1(2)),(AFFI ,BG1(102)),(BSI ,BG1(202)),	2577 663
2(BSO ,BG1(213)),(BHIGH ,BG1(224)),(CLOSSI,BG1(237)),	2578 663
3(CLSGEN,BG1(337)),(CLSM DI,BG1(438)),(DHD ,BG1(539)),	2579 663
4(DHI ,BG1(639)),(DPARAM,BG1(739)),(DPARMI,BG1(747)),	2580 663
5(FTABI ,BG1(755)),(FPARMI,BG1(759)),(FMULTI,BG1(768)),	2581 663
6(GMASS ,BG1(868)),(HTABI ,BG1(968)),(HEDDUM,BG1(974)),	2582 663
7(HMULTI,BG1(987)),(KPARAM,BG1(1087)),(KPARMR,BG1(1095)),	2583 663
8(KRSCON,BG1(1103)),(NDH ,BG1(1107)),(NAFL ,BG1(1207)),	2584 663
9(NLEN ,BG1(1307)),(NCLOSS,BG1(1407)),(NCLSM D,BG1(1507))	2585 663
EQUIVALENCE	2586 663
1(NHMULT,BG1(1607)),(NFMULT,BG1(1707)),(OLEND ,BG1(1808)),	2587 663
2(OLENI ,BG1(1908)),(PHISUM,BG1(2008)),(PHIEX ,BG1(2108)),	2588 663
3(P0 ,BG1(2208)),(P1 ,BG1(2308)),(P2 ,BG1(2408)),	2589 663
4(TEXI ,BG1(2508)),(TW ,BG1(2608)),(XOLD ,BG1(2708)),	2590 663
5(XOL ,BG1(2808)),(REYNO ,BG1(2908)),(FRIC ,BG1(3008)),	2591 663
6(CONVEC,BG1(3108)),(DPINT,BG1(3208)),(OMEXI,BG1(3308))	2592 663
7,(PRTGAS,BG1(3408)),(PSEXI,BG1(3417)),(PDYEXI,BG1(3517))	2593 663
*OPEN AT 3617, KEEP OPEN UNTIL 3700	2594 663
DIMENSION KONOPT(2,10),KONPAR(4,13),SAVTAB(13,100),KSVTAB(13,100)	2595 663
EQUIVALENCE(KONOPT,KUP,BG2),(KONPAR,BG2(21)),	2596 663
1(SAVTAB,KSVTAB,BG2(73))	2597 663
*OPEN 1373	2598 663
EQUIVALENCE(THICKD,BG3(2)),(NRINGD,BG3(103)),(PEXI,BG3(203))	2599 663
*	2600 663
* * * MASTER GROUPING	2601 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	2602 663
1BG(5474)	2603 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	2604 663
COMMON BG	2605 663
* * * END OF MASTER GROUPING	2606 663
*	2607 663
*END OF STORAGE MAP	2608 663
*	2609 663
DIMENSION GRTMPI(3)	2610 663
EQUIVALENCE(GRTMPI,BSO(2))	2611 663
*RESET TO ZERO	2612 663
DO 110 N=1,NOSTGE	2613 663
DHI(N)=0.	2614 663

OLENI(N)=0.	2615 66
AFFI(N)=0.	2616 66
CLSGEN(N)=0.	2617 66
FRIC(N)=0.	2618 66
CONVEC(N)=0.	2619 66
P0(N)=0.	2620 66
P1(N)=0.	2621 66
P2(N)=0.	2622 66
110 CONTINUE	2623 66
KASE=KASE+KASTEP	2624 66
IF(NEWSET)300,370,300	2625 66
*DID CONVERGENCE TAKE PLACE	2626 66
300 IF(SENSE LIGHT 2)310,320	2627 66
310 DEAD=1.	2628 66
CALL NETERR(200,1)	2629 66
SENSE LIGHT 4	2630 66
GO TO 360	2631 66
*REPLACE BSI WITH BSO	2632 66
320 CALL DSTRB1(BSO,11,BSI,0,0,KSIG)	2633 66
QBAR=QTOTD	2634 66
*CHECK UNITS	2635 66
IF(FTIN)325,335,325	2636 66
325 IF(FTOUT)340,330,340	2637 66
330 TRAN1=144.	2638 66
332 PTIN=PTIN*TRAN1	2639 66
PTEX=PTEX*TRAN1	2640 66
PSEX=PSEX*TRAN1	2641 66
GO TO 340	2642 66
335 IF(FTOUT)337,340,337	2643 66
337 TRAN1=1./144.	2644 66
GO TO 332	2645 66
340 IF(RNKIN)355,345,355	2646 66
345 IF(RNKOUT)350,360,350	2647 66
350 M=-1	2648 66
351 CALL CONTMP(GRTMPI,3,GRTMPI,M)	2649 66
DO 354 L=1,3	2650 66
IF(9999.+GRTMPI(L))354,352,354	2651 66
352 GRTMPI(L)=0.	2652 66
354 CONTINUE	2653 66
GO TO 360	2654 66
355 IF(RNKOUT)360,356,360	2655 66
356 M=1	2656 66
GO TO 351	2657 66
360 NEWSET=0	2658 66
370 CONTINUE	2659 66
RETURN	2660 66
END(0,1,0)	2661 66
* * * * *	2662 66
*SETYLD63 SR TO SELECT VALUE OF DEPENDENT VARIABLE FOR	2663 66
* CURRENT ITERATION OR SET RESULTS FOR OUTPUTTING FROM	2664 66
* FOR GFP(ANP 663)	2665 66
*FINAL SETUP IF I=0 OTHERWISE NORMAL ITERATION	2666 66
* PROCEDURE	2667 66
* SUBROUTINE SETYLD(ID,GD)	2668 66
* BEGIN STORAGE MAP	2669 66
	2670 66
	2671 66

* * * MASTER GROUPING	2672 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	2673 663
1BG(5474)	2674 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	2675 663
COMMON BG	2676 663
* * * END OF MASTER GROUPING	2677 663
*BASIC OPTIONAL VARIABLES	2678 663
DIMENSION GRTMPI(3),GRTMPO(3)	2679 663
EQUIVALENCE(PIN,BSI),(TIN,BSI(2)),(TEX,BSI(3)),(TWMAX,	2680 663
1BSI(4)),(PSEX,BSI(5)),(PEX,BSI(6)),(W,BSI(7)),(QTOT,	2681 663
2BSI(8)),(PIND,BSO),(TIND,BSO(2)),(TEXD,BSO(3)),(TWMAXD,	2682 663
3BSO(4)),(PSEXD,BSO(5)),(PEXD,BSO(6)),(WD,BSO(7)),(QTOTD,	2683 663
4BSO(8)),(PSXOPI,BSI(9)),(PTXOPI,BSI(10)),(TEXOTI,BSI(11)),	2684 663
5(PSPID,BSO(9)),(PTPID,BSO(10)),(TXTID,BSO(11)),	2685 663
6(GRTMPI,BSI(2)),(GRTMPO,BSO(2))	2686 663
DIMENSION TW(100),BSI(11),BSO(11)	2687 663
EQUIVALENCE(TW,BG1(2608)),(NHOT,BG0(45)),(KOPT,BG0(32)),	2688 663
1(BSI,BG1(202)),(BSO,BG1(213)),(DELH,BG0(14)),(MAXTMP,BG0(79)),	2689 663
2(KDD,BG0(77)),(NOSTGE,BG0(47))	2690 663
*END OF STORAGE MAP	2691 663
*	2692 663
I=ID	2693 663
MAXTMP=MAXTMP	2694 663
KDD=KDD	2695 663
IF(KOPT-2)115,115,110	2696 663
110 IF(I)180,120,180	2697 663
*CHECK IF STAGE SPECIFIED	2698 663
115 IF(MAXTMP)120,120,117	2699 663
117 TWMAXD=TW(MAXTMP)	2700 663
NHOT=MAXTMP	2701 663
GO TO 135	2702 663
*TWMAX	2703 663
120 TWMAXD=0.	2704 663
DO 130 N=1,NOSTGE	2705 663
IF(TWMAXD-TW(N))125,125,130	2706 663
125 TWMAXD=TW(N)	2707 663
NHOT=N	2708 663
130 CONTINUE	2709 663
135 IF(I)140,200,140	2710 663
140 GD=TWMAXD	2711 663
GO TO 230	2712 663
*ITERATION	2713 663
180 GD=BSO(KDD)	2714 663
GO TO 230	2715 663
200 CONTINUE	2716 663
*REMAINDER OF OUTPUT SETUP	2717 663
DO 210 M=1,7	2718 663
IF(KOPT-2*M+1)210,220,210	2719 663
210 CONTINUE	2720 663
*TEXD IS USER-SPECIFIED	2721 663
QTOTD=WD*DELH	2722 663
*SET UP RATIOS	2723 663
220 PSPID=PSEXD/PIND	2724 663
PTPID=PEXD/PIND	2725 663
TXTID=TEXD/TIND	2726 663
*SR FINISHED	2727 663
230 CONTINUE	2728 663


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RETURN
END(0,0,0)
* * * * *
*SUMPRT63 SR TO PRINT SUMMARIZED OUTPUT FOR UP
* TO 100 CASES FOR
*GFP 663 GENERAL FLOW PASSAGE
* S C SKIRVIN
*
SUBROUTINE SUMPRT
*
*BEGIN STORAGE MAP
*GENERAL USAGE
DIMENSION
1AFFI (100 ),BSI (11 ),BSO (11 ),CLOSSI(100 ),CLSGEN(100 ),
2CLSMDI(100 ),DHI (100 ),DPARAM(8 ),DPARM(8 ),FMULTI(100 ),
3FTABI (8 ),FPARMI(8 ),HTABI (6 ),HMULTI(100 ),KRSCON(4 ),
4KPARAM(8 ),KPARMR(8 ),NDH (100 ),NAFL (100 ),NLEN (100 ),
5NCLOSS(100 ),NCLSMD(100 ),NRINGD(100 ),NHMULT(100 ),NFMULT(100 ),
6OLENI (100 ),PHISUM(100 ),PHIEX (100 ),PO (100 ),P1 (100 ),
7P2 (100 ),THICKD(100 ),TEXI (100 ),XOLD (100 ),BHIGH (12 ),
8HEDDUM(12 ),GMASS (100 ),TW (100 ),REYNO (100 ),FRIC (100 ),
9CONVEC(100 ),DPINT(100 ),OMEXI(100 ),PRTGAS(9)
DIMENSION PSEXI(100 ),PDYEXI(100 ),PEXI(100)
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP
EQUIVALENCE
1(AD ,BG0(1 )),(ACCMNO,BG0(2 )),(ACCPRS,BG0(3 )),
2(ACCTMP,BG0(4 )),(ALLRUN,BG0(5 )),(AUTOLS,BG0(6 )),
3(BD ,BG0(7 )),(BLANKS,BG0(8 )),(BETA1 ,BG0(9 )),
4(BETA2 ,BG0(10 )),(CIN ,BG0(11 )),(CEX ,BG0(12 )),
5(DEAD ,BG0(13 )),(DELH ,BG0(14 )),(DERIV ,BG0(15 )),
6(ENTRN ,BG0(16 )),(ENTRNC,BG0(17 )),(FD ,BG0(18 )),
7(FTIN ,BG0(19 )),(FTOUT ,BG0(20 )),(FSTPAR,BG0(21 )),
8(GOAL ,BG0(22 )),(GAS ,BG0(23 )),(HIN ,BG0(24 )),
9(ITRY ,BG0(25 )),(KTRCRD,BG0(26 )),(KALCNO,BG0(27 ))
EQUIVALENCE
1(KTCHAD,BG0(28 )),(KTWADJ,BG0(29 )),(KTCHTO,BG0(30 )),
2(KPOW ,BG0(31 )),(KOPT ,BG0(32 )),(KOSCIL,BG0(33 )),
3(KCHKE,BG0(34 )),(KASE ,BG0(35 )),(KASTEP,BG0(36 )),
4(LOC ,BG0(37 )),(LIMCHK,BG0(38 )),(LMCHTO,BG0(39 )),
5(LIMTRY,BG0(40 )),(MORCAS,BG0(41 )),(NSKPPR,BG0(42 )),
6(NSKPHT,BG0(43 )),(NT ,BG0(44 )),(NHOT ,BG0(45 )),
7(NOPRT ,BG0(46 )),(NOSTGE,BG0(47 )),(PARPRT,BG0(48 )),
8(PRTSUM,BG0(49 )),(RNKIN ,BG0(50 )),(RNKOUT,BG0(51 )),
9(SVACMN,BG0(52 )),(SVACPR,BG0(53 )),(TOTLND,BG0(54 ))
EQUIVALENCE
1(TRY0 ,BG0(55 )),(TRY1 ,BG0(56 )),(TRY2 ,BG0(57 )),
2(TRY3 ,BG0(58 )),(TEST1 ,BG0(59 )),(TOTLEN,BG0(60 )),
3(WHI ,BG0(61 )),(WLO ,BG0(62 )),(YIELD0,BG0(63 )),
4(YIELD1,BG0(64 )),(YIELD2,BG0(65 )),(NOINPT,BG0(66 )),
5(LIMPRS,BG0(67 )),(PRTALL,BG0(68 )),(OMAXD ,BG0(69 )),
6(OMAX,BG0(70 )),(OMAX1,BG0(71 )),(KOPHT,BG0(72 )),
7(DMCONV,BG0(75 )),(KDI ,BG0(76 )),(KDD ,BG0(77 )),(TRYMAX,BG0(78 )),
8(878 )),(MAXTMP,BG0(79 )),(LMBULK,BG0(80 )),(TBBULK,BG0(81 )),
9(KCHK1,BG0(1 )),(KCHK2,BG0(7 )),(KCHK3,BG0(18 )),(KGAS,BG0(82 )),
EQUIVALENCE(PDYIN,BG0(73 )),(PDYEX,BG0(74 )),(OMINLT,BG0(83 )),
1(OMEXIT,BG0(84 )),(DPIN,BG0(85 )),(DPEX,BG0(86 )),
2(TRANSE ,BG0(87 )),(TRANH ,BG0(88 )),(TRANHL ,BG0(89 ))

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3,(NEWSET,BG0(90)),(KTPAR,BG0(91)),(KTOTPR,BG0(92)),(QBAR,BG0(93)),2786 663
4(QOQBAR,BG0(94)),(NOGEOM,BG0(95))2787 663
EQUIVALENCE2788 663
1(AFFD ,BG1(2 )),(AFFI ,BG1(102 )),(BSI ,BG1(202 )),2789 663
2(BSO ,BG1(213 )),(BHIGH ,BG1(224 )),(CLOSSI,BG1(237 )),2790 663
3(CLSGEN,BG1(337 )),(CLSM DI,BG1(438 )),(DHD ,BG1(539 )),2791 663
4(DHI ,BG1(639 )),(DPARAM,BG1(739 )),(DPARMI,BG1(747 )),2792 663
5(FTABI ,BG1(755 )),(FPARMI,BG1(759 )),(FMULTI,BG1(768 )),2793 663
6(GMASS ,BG1(868 )),(HTABI ,BG1(968 )),(HEDDUM,BG1(974 )),2794 663
7(HMULTI,BG1(987 )),(KPARAM,BG1(1087 )),(KPARMR,BG1(1095 )),2795 663
8(KRSCON,BG1(1103 )),(NDH ,BG1(1107 )),(NAFL ,BG1(1207 )),2796 663
9(NLEN ,BG1(1307 )),(NCLOSS,BG1(1407 )),(NCLSM D,BG1(1507 ))2797 663
EQUIVALENCE2798 663
1(NHMULT,BG1(1607 )),(NFMULT,BG1(1707 )),(OLEND ,BG1(1808 )),2799 663
2(OLENI ,BG1(1908 )),(PHISUM,BG1(2008 )),(PHIEX ,BG1(2108 )),2800 663
3(PO ,BG1(2208 )),(P1 ,BG1(2308 )),(P2 ,BG1(2408 )),2801 663
4(TEXI ,BG1(2508 )),(TW ,BG1(2608 )),(XOLD ,BG1(2708 )),2802 663
5(XOL ,BG1(2808 )),(REYNO ,BG1(2908 )),(FRIC ,BG1(3008 )),2803 663
6(CONVEC,BG1(3108)),(DPINT,BG1(3208)),(OMEXI,BG1(3308))2804 663
7,(PRTGAS,BG1(3408)),(PSEXI,BG1(3417)),(PDYEXI,BG1(3517))2805 663
*OPEN AT 3617, KEEP OPEN UNTIL 37002806 663
DIMENSION KONOPT(2,10),KONPAR(4,13),SAVTAB(13,100),KSVTAB(13,100)2807 663
EQUIVALENCE(KONOPT,KUP,BG2),(KONPAR,BG2(21)),2808 663
1(SAVTAB,KSVTAB,BG2(73))2809 663
*OPEN 13732810 663
EQUIVALENCE(THICKD,BG3(2)),(NRINGD,BG3(103)),(PEXI,BG3(203))2811 663
*2812 663
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2)),(COFFTB,2813 663
1FTABI(3)),(EXPFTB,FTABI(4))2814 663
*2815 663
*BASIC OPTIONAL VARIABLES2816 663
DIMENSION GRTMPI(3),GRTMPO(3)2817 663
EQUIVALENCE(PIN,BSI),(TIN,BSI(2)),(TEX,BSI(3)),(TWMAX,2818 663
1BSI(4)),(PSEX,BSI(5)),(PEX,BSI(6)),(W,BSI(7)),(QTOT,2819 663
2BSI(8)),(PIND,BSO),(TIND,BSO(2)),(TEXD,BSO(3)),(TWMAXD,2820 663
3BSO(4)),(PSEXD,BSO(5)),(PEXD,BSO(6)),(WD,BSO(7)),(QTOTD,2821 663
4BSO(8)),(PSXOPI,BSI(9)),(PTXOPI,BSI(10)),(TEXOTI,BSI(11)),2822 663
5(PSPID,BSO(9)),(PTPID,BSO(10)),(TXTID,BSO(11)),2823 663
6(GRTMPI,BSI(2)),(GRTMPO,BSO(2))2824 663
*2825 663
EQUIVALENCE(COFHLM,HTABI),(EXHPLM,HTABI(2)),(EXHRLM,2826 663
1HTABI(3)),(COFHTB,HTABI(4)),(EXHPTB,HTABI(5)),(EXHRTB,2827 663
2HTABI(6))2828 663
EQUIVALENCE(DPTIN,DPARAM),(DTTIN,DPARAM(2)),(DTTEX,DPARAM(3)),2829 663
1(DTWMAX,DPARAM(4)),(DPSEX,DPARAM(5)),(DPTEX,DPARAM(6)),(DW,DPARAM(2830 663
27)),(DQTOT,DPARAM(8)),(NOPTIN,KPARAM),2831 663
3(NOTTIN,KPARAM(2)),(NOTTEX,KPARAM(3)),(NOTWMX,NTWMAX,NOTWA,2832 663
4KPARAM(4)),(NOPSEX,KPARAM(5)),(NOPTEX,KPARAM(6)),(NOW,KPARAM(7)),2833 663
5(NOQTOT,KPARAM(8))2834 663
*2835 663
* * * MASTER GROUPING2836 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),2837 663
1BG(5474)2838 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))2839 663
COMMON BG2840 663
* * * END OF MASTER GROUPING2841 663
*2842 663

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*END OF STORAGE MAP	2843 663
*	2844 663
KALCNO=KALCNO	2845 663
KGAS=KGAS	2846 663
KTEST=8-KALCNO/2	2847 663
*SET UNITS LENGTH	2848 663
KD1=1	2849 663
IF(FTOUT)120,120,110	2850 663
110 KD1=2	2851 663
*TEMP	2852 663
120 KD2=1	2853 663
IF(RNKOUT)140,140,130	2854 663
130 KD2=2	2855 663
140 KRT=1	2856 663
*CHECK NEED FOR UNIT CHANGES	2857 663
IF(FTOUT)170,170,150	2858 663
*LENGTH	2859 663
150 DO 160 K=1,KALCNO	2860 663
SAVTAB(2,K)=SAVTAB(2,K)*144.	2861 663
SAVTAB(6,K)=SAVTAB(6,K)*144.	2862 663
SAVTAB(7,K)=SAVTAB(7,K)*144.	2863 663
160 CONTINUE	2864 663
170 IF(RNKOUT)180,180,200	2865 663
*TEMPERATURE	2866 663
180 DO 190 K=1,KALCNO	2867 663
CALL CONTMP(SAVTAB(3,K),3,SAVTAB(3,K),-1)	2868 663
190 CONTINUE	2869 663
*NORMAL CONTINUATION PRINT UNIT HEADING	2870 663
200 CALL PRTUNT(2,KD1,KD2)	2871 663
GO TO(210,250,230),KRT	2872 663
*START SUMMARY TABLE	2873 663
210 KL=1	2874 663
KU=KALCNO	2875 663
EXIT=1.	2876 663
IF(41-KALCNO)220,230,230	2877 663
220 KU=41	2878 663
EXIT=0.	2879 663
230 KD=KU-KL+1	2880 663
PRINT 32005,KD,PRTGAS(KGAS),KGAS,KSVTAB(1,KL),	2881 663
1KSVTAB(1,KU),(KSVTAB(1,K),SAVTAB(8,K),SAVTAB(2,K),	2882 663
2SAVTAB(7,K),SAVTAB(11,K),SAVTAB(6,K),SAVTAB(10,K),	2883 663
3K=KL,KU)	2884 663
32005 FORMAT	2885 663
SPACE	2886 663
SUMMARY PRINTOUT FOR -I POINTS (GAS IS-X -A, NO -I)	2887 663
(CASES -I THRU -I)	2888 663
SPACE	2889 663
CASE WEIGHT INLET EXIT PTEX/ EXIT PSEX/	2890 663
SPACE FLOW P-TOT P-TOT PTIN P-STAT PTIN	2891 663
-I -1PE5 -0PF3 -F3 -F5 -F3 -F5	2892 663
REPEAT 1	2893 663
END OF FORMAT	2894 663
*	2895 663
IF(KTEST)240,250,250	2896 663
240 KRT=2	2897 663
GO TO 200	2898 663
	2899 663

250 PRINT 32010,KD,PRTGAS(KGAS),KGAS,KSVTAB(1,KL),	2900 663
1KSVTAB(1,KU),(KSVTAB(1,K),SAVTAB(3,K),SAVTAB(4,K),	2901 663
2SAVTAB(12,K),SAVTAB(9,K),SAVTAB(5,K),KSVTAB(13,K),	2902 663
3K=KL,KU)	2903 663
32010 FORMAT	2904 663
SPACE	2905 663
SUMMARY PRINTOUT FOR -I POINTS (GAS IS-X -A, NO -I)	2906 663
(CASES -I THRU -I)	2907 663
SPACE	2908 663
INLET EXIT TTEX/ HEAT MAX AVE	2909 663
CASE T-TOT T-TOT TTIN ADDITION SURF-TEMP AT STGE	2910 663
SPACE	2911 663
-I -OPF1 -F1 -F5 -1PE5 -OPF1 -I	2912 663
REPEAT 1	2913 663
END OF FORMAT	2914 663
*	2915 663
IF(EXIT)300,260,300	2916 663
260 KL=KU+1	2917 663
KRT=3	2918 663
IF(86-KALCNO)270,290,290	2919 663
270 IF(86-KU)290,290,280	2920 663
280 KU=86	2921 663
GO TO 200	2922 663
290 KU=KALCNO	2923 663
EXIT=1.	2924 663
GO TO 200	2925 663
*FINISHED	2926 663
300 KALCNO=0	2927 663
RETURN	2928 663
END(0,0,0)	2929 663
* * * * *	2930 663
CTWLT 00 A SR TO CALCULATE WALL TEMPS FOR LALMINAR OR TURBULENT FLOW	2931 663
* WITH OR WITHOUT ENTRANCE LENGTH EFFECTS	2932 663
*GFP 663 GENERAL FLOW PASSAGE	2933 663
*	2934 663
SUBROUTINE TWLT(IDENT)	2935 663
*	2936 663
*BEGIN STORAGE MAP	2937 663
*GENERAL USEAGE	2938 663
DIMENSION	2939 663
1AFFI (100),BSI (11),BSO (11),CLOSSI(100),CLSGEN(100),	2940 663
2CLSM DI(100),DHI (100),DPARAM(8),DPARMI(8),FMULTI(100),	2941 663
3FTABI (8),FPARMI(8),HTABI (6),HMULTI(100),KRSCON(4),	2942 663
4KPARAM(8),KPARMR(8),NDH (100),NAFL (100),NLEN (100),	2943 663
5NCLOSS(100),NCLSM DI(100),NRINGD(100),NHMULT(100),NFMULT(100),	2944 663
6OLENI (100),PHISUM(100),PHIEX (100),PO (100),P1 (100),	2945 663
7P2 (100),THICKD(100),TEXI (100),XOLD (100),BHIGH (12),	2946 663
8HEDDUM(12),GMASS (100),TW (100),REYNO (100),FRIC (100),	2947 663
9CONVEC(100),DPINT(100),OMEXI(100),PRTGAS(9)	2948 663
DIMENSION PSEXI(100),PDYEXI(100),PEXI(100)	2949 663
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP	2950 663
EQUIVALENCE	2951 663
1(AD ,BG0(1)),(ACCMNO,BG0(2)),(ACCPRS,BG0(3)),	2952 663
2(ACCTMP,BG0(4)),(ALLRUN,BG0(5)),(AUTOLS,BG0(6)),	2953 663
3(BD ,BG0(7)),(BLANKS,BG0(8)),(BETA1 ,BG0(9)),	2954 663
4(BETA2 ,BG0(10)),(CIN ,BG0(11)),(CEX ,BG0(12)),	2955 663
5(DEAD ,BG0(13)),(DELH ,BG0(14)),(DERIV ,BG0(15)),	2956 663

6(ENTRN ,BG0(16)),(ENTRNC,BG0(17)),(FD ,BG0(18)),	2957 663
7(FTIN ,BG0(19)),(FTOUT ,BG0(20)),(FSTPAR,BG0(21)),	2958 663
8(GOAL ,BG0(22)),(GAS ,BG0(23)),(HIN ,BG0(24)),	2959 663
9(ITRY ,BG0(25)),(KTRCRD,BG0(26)),(KALCNO,BG0(27))	2960 663
EQUIVALENCE	2961 663
1(KTCHAD,BG0(28)),(KTWADJ,BG0(29)),(KTCHTO,BG0(30)),	2962 663
2(KPOW ,BG0(31)),(KOPT ,BG0(32)),(KOSCIL,BG0(33)),	2963 663
3(KCHOKE,BG0(34)),(KASE ,BG0(35)),(KASTEP,BG0(36)),	2964 663
4(LOC ,BG0(37)),(LIMCHK,BG0(38)),(LMCHTO,BG0(39)),	2965 663
5(LIMTRY,BG0(40)),(MORCAS,BG0(41)),(NSKPPR,BG0(42)),	2966 663
6(NSKPHT,BG0(43)),(NT ,BG0(44)),(NHOT ,BG0(45)),	2967 663
7(NOPRT ,BG0(46)),(NOSTGE,BG0(47)),(PARPRT,BG0(48)),	2968 663
8(PRTSUM,BG0(49)),(RNKIN ,BG0(50)),(RNKOUT,BG0(51)),	2969 663
9(SVACMN,BG0(52)),(SVACPR,BG0(53)),(TOTLND,BG0(54))	2970 663
EQUIVALENCE	2971 663
1(TRY0 ,BG0(55)),(TRY1 ,BG0(56)),(TRY2 ,BG0(57)),	2972 663
2(TRY3 ,BG0(58)),(TEST1 ,BG0(59)),(TOTLEN,BG0(60)),	2973 663
3(WHI ,BG0(61)),(WLO ,BG0(62)),(YIELD0,BG0(63)),	2974 663
4(YIELD1,BG0(64)),(YIELD2,BG0(65)),(NOINPT,BG0(66)),	2975 663
5(LIMPRS,BG0(67)),(PRTALL,BG0(68)),(OMAXD ,BG0(69)),	2976 663
6(OMAX,BG0(70))),(OMAX1,BG0(71))),(KOPTH,BG0(72)),	2977 663
7 (DMCONV,BG0(75))),(KDI,BG0(76))),(KDD,BG0(77))),(TRYMAX,BG0(	2978 663
878))),(MAXTMP,BG0(79))),(LMBULK,BG0(80))),(TBBULK,BG0(81)),	2979 663
9(KCHK1,BG0(1))),(KCHK2,BG0(7))),(KCHK3,BG0(18))),(KGAS,BG0(82))	2980 663
EQUIVALENCE(PDYIN,BG0(73))),(PDYEX,BG0(74))),(OMINLT,BG0(83)),	2981 663
1(OMEXIT,BG0(84))),(DPIN,BG0(85))),(DPEX,BG0(86))	2982 663
2,(TRANSF,BG0(87))),(TRANHL,BG0(88))),(TRANHU,BG0(89))	2983 663
3,(NEWSET,BG0(90))),(KTPAR,BG0(91))),(KTOTPR,BG0(92))),(QBAR,BG0(93)),	2984 663
4(QOQBAR,BG0(94))),(NOGEOM,BG0(95))	2985 663
EQUIVALENCE	2986 663
1(AFFD ,BG1(2)),(AFFI ,BG1(102)),(BSI ,BG1(202)),	2987 663
2(BSO ,BG1(213)),(BHIGH ,BG1(224)),(CLOSSI,BG1(237)),	2988 663
3(CLSGEN,BG1(337)),(CLSMDI,BG1(438)),(DHD ,BG1(539)),	2989 663
4(DHI ,BG1(639)),(DPARAM,BG1(739)),(DPARMI,BG1(747)),	2990 663
5(FTABI ,BG1(755)),(FPARMI,BG1(759)),(FMULTI,BG1(768)),	2991 663
6(GMASS ,BG1(868)),(HTABI ,BG1(968)),(HEDDUM,BG1(974)),	2992 663
7(HMULTI,BG1(987)),(KPARAM,BG1(1087)),(KPARMR,BG1(1095)),	2993 663
8(KRSCON,BG1(1103)),(NDH ,BG1(1107)),(NAFL ,BG1(1207)),	2994 663
9(NLEN ,BG1(1307)),(NCLOSS,BG1(1407)),(NCLSMD,BG1(1507))	2995 663
EQUIVALENCE	2996 663
1(NHMULT,BG1(1607)),(NFMULT,BG1(1707)),(OLEND ,BG1(1808)),	2997 663
2(OLENI ,BG1(1908)),(PHISUM,BG1(2008)),(PHIEX ,BG1(2108)),	2998 663
3(P0 ,BG1(2208)),(P1 ,BG1(2308)),(P2 ,BG1(2408)),	2999 663
4(TEXI ,BG1(2508)),(TW ,BG1(2608)),(XOLD ,BG1(2708)),	3000 663
5(XOL ,BG1(2808)),(REYNO ,BG1(2908)),(FRIC ,BG1(3008)),	3001 663
6(CONVEC,BG1(3108))),(DPINT,BG1(3208))),(OMEXI,BG1(3308))	3002 663
7,(PRTGAS,BG1(3408))),(PSEXI,BG1(3417))),(PDYEXI,BG1(3517))	3003 663
*OPEN AT 3617, KEEP OPEN UNTIL 3700	3004 663
DIMENSION KONOPT(2,10),KONPAR(4,13),SAVTAB(13,100),KSVTAB(13,100)	3005 663
EQUIVALENCE(KONOPT,KUP,BG2),(KONPAR,BG2(21)),	3006 663
1(SAVTAB,KSVTAB,BG2(73))	3007 663
*OPEN 1373	3008 663
EQUIVALENCE(THICKD,BG3(2))),(NRINGD,BG3(103))),(PEXI,BG3(203))	3009 663
*	3010 663
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2))),(COFFTB,	3011 663
1FTABI(3))),(EXPFTB,FTABI(4))	3012 663
*	3013 663

*BASIC OPTIONAL VARIABLES	3014 663
DIMENSION GRTMPI(3),GRTMPO(3)	3015 663
EQUIVALENCE(PIN,BSI),(TIN,BSI(2)),(TEX,BSI(3)),(TWMAX,	3016 663
1BSI(4)),(PSEX,BSI(5)),(PEX,BSI(6)),(W,BSI(7)),(QTOT,	3017 663
2BSI(8)),(PIND,BSO),(TIND,BSO(2)),(TEXD,BSO(3)),(TWMAXD,	3018 663
3BSO(4)),(PSEX,BSO(5)),(PEXD,BSO(6)),(WD,BSO(7)),(QTOTD,	3019 663
4BSO(8)),(PSXOP,BSI(9)),(PTXOP,BSI(10)),(TEXOT,BSI(11)),	3020 663
5(PSPID,BSO(9)),(PTPID,BSO(10)),(TXTID,BSO(11)),	3021 663
6(GRTMPI,BSI(2)),(GRTMPO,BSO(2))	3022 663
*	3023 663
EQUIVALENCE(COFHLM,HTABI),(EXHPLM,HTABI(2)),(EXHRLM,	3024 663
1HTABI(3)),(COFHTB,HTABI(4)),(EXHPTB,HTABI(5)),(EXHRTB,	3025 663
2HTABI(6))	3026 663
EQUIVALENCE(DPTIN,DPARAM),(DTTIN,DPARAM(2)),(DTTEX,DPARAM(3)),	3027 663
1(DTWMAX,DPARAM(4)),(DPSEX,DPARAM(5)),(DPTEX,DPARAM(6)),(DW,DPARAM	3028 663
27)),(DQTOT,DPARAM(8)),(NOPTIN,KPARAM),	3029 663
3(NOTTIN,KPARAM(2)),(NOTTEX,KPARAM(3)),(NOTWMX,NTWMAX,NOTWA,	3030 663
4KPARAM(4)),(NOPSEX,KPARAM(5)),(NOPTEX,KPARAM(6)),(NOW,KPARAM(7)),	3031 663
5(NOQTOT,KPARAM(8))	3032 663
*	3033 663
* * * MASTER GROUPING	3034 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	3035 663
1BG(5474)	3036 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	3037 663
COMMON BG	3038 663
* * * END OF MASTER GROUPING	3039 663
*	3040 663
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2)),(COFFTB,FTABI(3)),	3041 663
1(EXPFTB,FTABI(4)),(ND,NOSTGE),(G,GMASS),(REAVG,REYNO),	3042 663
2(OMEX,OMEXI)	3043 663
DIMENSION G(100),REAVG(100),OMEX(100)	3044 663
DIMENSION AQPR(2)	3045 663
EQUIVALENCE(A,AQPR),(QPR,AQPR(2))	3046 663
DIMENSION TSTGR(13)	3047 663
EQUIVALENCE(VIP,TSTGR),(TSTP,TSTGR(2)),(VIM,TSTGR(3)),	3048 663
1(TSTM,TSTGR(4)),(VIMX,TSTGR(5)),(VIMN,TSTGR(6)),	3049 663
2(VIO,TSTGR(7)),(VI1,TSTGR(8)),(VI2,TSTGR(9)),(VI3,TSTGR(10)),	3050 663
3(VDO,TSTGR(11)),(VD1,TSTGR(12)),(VD2,TSTGR(13))	3051 663
*END OF STORAGE MAP	3052 663
*	3053 663
IF(IDENT)90,95,90	3054 663
90 PRINT 32000	3055 663
32000 FORMAT	3056 663
SPACE 3	3057 663
**** WALL TEMP CALC (SR TWLT) HAS FULL FANTAN (ANP 542)	3058 663
**** ANALYSIS WITH TRANSITION AND ENTRANCE LENGTH EFFECTS.	3059 663
**** PROPERTY FUNCTIONS(R,ENFRMT,TFRMEN,VISC,PRN,TC) DE-	3060 663
**** TERMINE WHICH GASES CAN BE HANDLED.	3061 663
END OF FORMAT	3062 663
*	3063 663
GO TO 460	3064 663
*	3065 663
*INITIALIZE	3066 663
95 TAVG=TEXI(1)	3067 663
CALL FPRNT(4HTEXI,TEXI,ITRY,NOSTGE,KCHK3)	3068 663
SUMLEN=0.	3069 663
TINI=TIND	3070 663

*SET STAGE LOOP	3071 66
DO 450 N=1,ND	3072 66
DO 98 L=1,13	3073 66
VFACT=1.	3074 66
98 TSTGR(L)=0.	3075 66
TLO=0.	3076 66
THI=1.E+5	3077 66
TAVGL=(TINI+TEXI(N))/2.	3078 66
REYNO(N)=G(N)*DHI(N)*12./VISC(TAVGL,GAS)	3079 66
*SET KTRAN TO INDICATE TRANSITION	3080 66
*SET NOSKIP=0 IF NO FILM TEMP CALC NEEDED	3081 66
NOSKIP=0	3082 66
IF(REYNO(N)-TRANHL)102,102,110	3083 66
*LAMINAR	3084 66
102 KTRAN=-1	3085 66
IF(LMBULK)140,105,140	3086 66
105 NOSKIP=1	3087 66
GO TO 140	3088 66
110 IF(REYNO(N)-TRANHU)120,130,130	3089 66
*TRANSITION	3090 66
120 KTRAN=0	3091 66
EQUIVALENCE(KTBULK,TBBULK)	3092 66
IF(LMBULK*KTBULK)140,125,140	3093 66
125 NOSKIP=1	3094 66
GO TO 140	3095 66
*TURBULENT	3096 66
130 KTRAN=+1	3097 66
IF(TBBULK)140,135,140	3098 66
135 NOSKIP=1	3099 66
140 CONTINUE	3100 66
IF(N 1)180,180,190	3101 66
180 SDELH=DELH*PHISUM(N)	3102 66
GO TO 200	3103 66
190 SDELH=DELH*(PHISUM(N)-PHISUM(N-1))	3104 66
200 IF(OLENI(N))210,210,215	3105 66
210 TW(N)=TEXI(N)	3106 66
CONVEC(N)=0.	3107 66
GO TO 420	3108 66
215 CONTINUE	3109 66
CALL FPRNT(5HSDELH,SDELH,N,1,KCHK3)	3110 66
CON1=4.*OLENI(N)/(GMASS(N)*PHIEX(N)*DHI(N))	3111 66
CALL FPRNT(4HCON1,CON1,N,1,KCHK3)	3112 66
SUMLEN=SUMLEN+OLENI(N)	3113 66
VISCAV=VISC(TEXI(N),GAS)	3114 66
KTPRS=1	3115 66
*ITERATION RETURN	3116 66
220 TFACT=VFACT*TEXI(N)/TAVG	3117 66
FREYNO=REYNO(N)*TFACT	3118 66
CALL FPRNT(6HFREYNO,FREYNO,KTPRS,1,KCHK3)	3119 66
CALL FPRNT(4HTAVG,TAVG,KTPRS,1,KCHK3)	3120 66
STGPRN=PRN(TAVG,GAS)	3121 66
*SELECT N(RE) RANGE	3122 66
IF(KTRAN)240,290,260	3123 66
*	3124 66
*LAMINAR	3125 66
240 KRT=1	3126 66
245 STGNNU=HTABI(1)*(STGPRN**HTABI(2))*(FREYNO**HTABI(3))	3127 66

*IS ENTRANCE LENGTH EFFECT (ELE) WANTED	3128 663
IF(ENTRN)255,255,250	3129 663
*ELE WANTED	3130 663
250 STGNNU=(STGNNU**3+1.225*FREYNO*STGPRN*(DHI(N)/SUMLEN))**.33333	3131 663
255 GO TO(320,300),KRT	3132 663
*	3133 663
*TURBULENT	3134 663
260 KRT=1	3135 663
265 STGNNU=HTABI(4)*(STGPRN**HTABI(5))*(FREYNO**HTABI(6))	3136 663
*IS ELE WANTED	3137 663
IF(ENTRN)285,285,270	3138 663
*ELE WANTED	3139 663
270 IF(SUMLEN/DHI(N)-FREYNO**.25)280,285,285	3140 663
280 STGNNU=1.5*STGNNU*(DHI(N)/SUMLEN)**.16	3141 663
285 GO TO(320,310),KRT	3142 663
*	3143 663
*TRANSITIONAL	3144 663
290 KRT=2	3145 663
SVTRL=TRANHL	3146 663
TRANHL=TRANHL*TFAC	3147 663
SVTRU=TRANHU	3148 663
TRANHU=TRANHU*TFAC	3149 663
SVNRE=FREYNO	3150 663
FREYNO=TRANHL	3151 663
GO TO 245	3152 663
300 PRN103=STGPRN**.3333	3153 663
ETA0=STGNNU/(FREYNO*PRN103)	3154 663
ETA0L=LOGF(ETA0)	3155 663
FREYNO=TRANHU	3156 663
GO TO 265	3157 663
310 ETA1=STGNNU/(FREYNO*PRN103)	3158 663
FREYNO=SVNRE	3159 663
A=((TRANHU*TRANHL)/(TRANHL-TRANHU))*(TRANHU*	3160 663
1(LOGF(ETA1)-ETA0L)/(-(TRANHL-TRANHU))-(HTABI(6)-1.))	3161 663
B=(A/TRANHU+HTABI(6)-1.)/TRANHU	3162 663
C=ETA0L-A/TRANHL-B*TRANHL	3163 663
ETA=EXP(A/FREYNO+B*FREYNO+C)	3164 663
STGNNU=ETA*FREYNO*PRN103	3165 663
TRANHL=SVTRL	3166 663
TRANHU=SVTRU	3167 663
*	3168 663
*NUSSELT NO CALCULATED	3169 663
320 CONVEC(N)=STGNNU*TC(TAVG,GAS)/DHI(N)	3170 663
1*HMULTI(N)	3171 663
CALL FPRNT(6HSTGNNU,STGNNU,KTPRS,1,KCHK3)	3172 663
CALL FPRNT(6HCONVEC,CONVEC(N),N,1,KCHK3)	3173 663
IF(KTPRS-2)325,360,360	3174 663
325 TWN=TEXI(N)+SDELH/(CON1*CONVEC(N))	3175 663
CALL FPRNT(3HTWN,TWN,N,1,KCHK3)	3176 663
*TEST FOR SIMULTANEOUS BULK CORRELATIONS	3177 663
IF(NOSKIP)330,420,330	3178 663
330 IF(KTPRS-1)336,332,336	3179 663
*FIRST PASS	3180 663
332 VIO=TWN	3181 663
VI1=TWN	3182 663
VI2=TWN	3183 663
*STEP ITERATION COUNTER AND CALC FILM TEMP	3184 663

334 KTPRS=KTPRS+1	3185 66:
TAVG=(TWN+TEXI(N))/2.	3186 66:
VFACT=VISCAV/VISC(TAVG,GAS)	3187 66:
GO TO 220	3188 66:
*CONVERGENCE TEST	3189 66:
336 IF(ABSF(TWN-VI1)-ACCTMP)420,420,350	3190 66:
*NOT CONVERGED - IS COUNTER EXCEEDED	3191 66:
350 IF(LIMPRS-KTPRS)352,354,354	3192 66:
*EXCEEDED	3193 66:
352 TW(N)=TEXI(N)	3194 66:
353 CALL NETERR(190,N)	3195 66:
SENSE LIGHT 2	3196 66:
GO TO 422	3197 66:
*NOT EXCEEDED	3198 66:
354 CONTINUE	3199 66:
*IS JOB BEING PULLED ON TIME	3200 66:
IF(SENSE SWITCH 4)356,358	3201 66:
356 CALL NETERR(520,N)	3202 66:
GO TO 460	3203 66:
*NOT PULLED	3204 66:
358 IF(KTPRS-2)380,380,334	3205 66:
*NORMAL CONTINUATION	3206 66:
360 ENTRY=CONVEC(N)*CON1*(TWN-TEXI(N))	3207 66:
CALL FPRNT(5HENTRY,ENTRY,KTPRS,1,KCHK3)	3208 66:
TESTD=SDELH-ENTRY	3209 66:
CALL FPRNT(5HTESTD,TESTD,KTPRS,1,KCHK3)	3210 66:
*TEST FOR BOUNDS	3211 66:
IF(TESTD)368,420,362	3212 66:
*HAS POS BOUND BEEN SET	3213 66:
362 IF(TSTP)366,364,366	3214 66:
*SET POS BOUND	3215 66:
364 TSTP=TESTD	3216 66:
VIP=VI2	3217 66:
GO TO 374	3218 66:
*TEST POS BOUND	3219 66:
366 IF(TSTP-TESTD)374,374,364	3220 66:
*HAS NEG BOUND BEEN SET	3221 66:
368 IF(TSTM)372,370,372	3222 66:
*SET NEG BOUND	3223 66:
370 TSTM=TESTD	3224 66:
VIM=VI2	3225 66:
GO TO 374	3226 66:
*TEST NEG BOUND	3227 66:
372 IF(TESTD-TSTM)374,374,370	3228 66:
*CAN MAX-MIN BE ESTABLISHED	3229 66:
374 IF(TSTP*TSTM)376,378,376	3230 66:
*SET MAX-MIN	3231 66:
376 VIMX=MAX1F(VIP,VIM)	3232 66:
VIMN=MIN1F(VIP,VIM)	3233 66:
CALL FPRNT(6HMAXMIN,VIMX,KTPRS,2,KCHK3)	3234 66:
378 CONTINUE	3235 66:
CALL FPRNT(6HBND+/-,VIP,KTPRS,4,KCHK3)	3236 66:
IF(KTPRS-3)325,382,402	3237 66:
*SECOND ITERATION	3238 66:
380 VDO=ENTRY	3239 66:
VI1=TWN	3240 66:
VI2=TWN	3241 66:

GO TO 334	3242 663
*THIRD ITERATION	3243 663
382 VD1=ENTRY	3244 663
CALL EXTRAP(0,0,VIO,VD0,VI1,VD1,TWN,SDELH,2)	3245 663
383 VI3=TWN	3246 663
*HAVE MAX-MIN LIMITS BEEN SET	3247 663
384 IF(VIMX*VIMN)386,394,386	3248 663
*TEST AGAINST MAX-MIN BOUNDS	3249 663
386 IF(TWN-VIMN)390,390,388	3250 663
388 IF(VIMX-TWN)390,390,392	3251 663
*DICHOTIMIZE	3252 663
390 TWN=(VIMX+VIMN)/2.	3253 663
*RETURN FOR NEXT PASS	3254 663
392 VI2=TWN	3255 663
CALL FPRNT(5HVI0-3,VIO,KTPRS,4,KCHK3)	3256 663
CALL FPRNT(3HTWN,TWN,N,1,KCHK3)	3257 663
GO TO 336	3258 663
*TEST AGAINST GROSS LIMITS	3259 663
394 IF(THI-TWN)396,396,398	3260 663
*REDUCE	3261 663
396 TWN=.5*(THI+MAX1F(VIO,VI1))	3262 663
GO TO 392	3263 663
398 IF(TWN-TLO)400,400,392	3264 663
*INCREASE	3265 663
400 TWN=MIN1F(VIO,VI1)/2.	3266 663
GO TO 392	3267 663
*FOURTH AND SUBSEQUENT PASSES	3268 663
402 VD2=ENTRY	3269 663
CALL FPRNT(5HVD0-2,VD0,KTPRS,3,KCHK3)	3270 663
CALL EXTRAP(VIO,VD0,VI1,VD1,VI2,VD2,TWN,SDELH,3)	3271 663
VIO=VI1	3272 663
VI1=VI2	3273 663
VD0=VD1	3274 663
VD1=VD2	3275 663
GO TO 383	3276 663
*	3277 663
*NORMAL CONVERGED CONTINUATION	3278 663
420 TW(N)=TWN	3279 663
*IS JOB BEING PULLED ON TIME	3280 663
422 IF(SENSE SWITCH 4)356,425	3281 663
*IS THIS LAST STAGE	3282 663
425 IF(ND-N)460,460,440	3283 663
*DELETE 3284-3285	3284 663
440 TAVG=TEXI(N+1)	3286 663
450 TINI=TEXI(N)	3287 663
*	3288 663
*FINISHED	3289 663
460 CONTINUE	3290 663
RETURN	3291 663
END(0,1,0)	3292 663
* * * * *	3293 663
CUNCHKE00 SR TO ALLEVIATE CHOKES FOR	3294 663
*GFP 663 GENERAL FLOW PASSAGE	3295 663
* S C SKIRVIN	3296 663
*	3297 663
SUBROUTINE UNCHKE	3298 663
*	3299 663

*BEGIN STORAGE MAP	3300 663
*GENERAL USEAGE	3301 663
DIMENSION	3302 663
1AFFI (100),BSI (11),BSO (11),CLOSSI(100),CLSGEN(100),	3303 663
2CLSM DI(100),DHI (100),DPARAM(8),DPARMI(8),FMULTI(100),	3304 663
3FTABI (8),FPARMI(8),HTABI (6),HMULTI(100),KRSCON(4),	3305 663
4KPARAM(8),KPARMR(8),NDH (100),NAFL (100),NLEN (100),	3306 663
5NCLOSS(100),NCLSM D(100),NRINGD(100),NHMULT(100),NFMULT(100),	3307 663
6OLENI (100),PHISUM(100),PHIEX (100),PO (100),P1 (100),	3308 663
7P2 (100),THICKD(100),TEXI (100),XOLD (100),BHIGH (12),	3309 663
8HEDDUM(12),GMASS (100),TW (100),REYNO (100),FRIC (100),	3310 663
9CONVEC(100),DPINT(100),OMEXI(100),PRTGAS(9)	3311 663
DIMENSION PSEXI(100),PDYEXI(100),PEXI(100)	3312 663
*BG0 NON-SUBSCRIPTED, BG1 SINGLE, BG2 DOUBLE, BG3 CLEANUP	3313 663
EQUIVALENCE	3314 663
1(AD ,BG0(1)),(ACCMNO,BG0(2)),(ACCPRS,BG0(3)),	3315 663
2(ACCTMP,BG0(4)),(ALLRUN,BG0(5)),(AUTOLS,BG0(6)),	3316 663
3(BD ,BG0(7)),(BLANKS,BG0(8)),(BETA1 ,BG0(9)),	3317 663
4(BETA2 ,BG0(10)),(CIN ,BG0(11)),(CEX ,BG0(12)),	3318 663
5(DEAD ,BG0(13)),(DELH ,BG0(14)),(DERIV ,BG0(15)),	3319 663
6(ENTRN ,BG0(16)),(ENTRNC,BG0(17)),(FD ,BG0(18)),	3320 663
7(FTIN ,BG0(19)),(FTOUT ,BG0(20)),(FSTPAR,BG0(21)),	3321 663
8(GOAL ,BG0(22)),(GAS ,BG0(23)),(HIN ,BG0(24)),	3322 663
9(ITRY ,BG0(25)),(KTRCRD,BG0(26)),(KALCNO,BG0(27))	3323 663
EQUIVALENCE	3324 663
1(KTCHAD,BG0(28)),(KTWADJ,BG0(29)),(KTCHTO,BG0(30)),	3325 663
2(KPOW ,BG0(31)),(KOPT ,BG0(32)),(KOSCIL,BG0(33)),	3326 663
3(KCHKE,BG0(34)),(KASE ,BG0(35)),(KASTEP,BG0(36)),	3327 663
4(LOC ,BG0(37)),(LIMCHK,BG0(38)),(LMCHTO,BG0(39)),	3328 663
5(LIMTRY,BG0(40)),(MORCAS,BG0(41)),(NSKPPR,BG0(42)),	3329 663
6(NSKPHT,BG0(43)),(NT ,BG0(44)),(NHOT ,BG0(45)),	3330 663
7(NOPRT ,BG0(46)),(NOSTGE,BG0(47)),(PARPRT,BG0(48)),	3331 663
8(PRTSUM,BG0(49)),(RNKIN ,BG0(50)),(RNKOUT,BG0(51)),	3332 663
9(SVACMN,BG0(52)),(SVACPR,BG0(53)),(TOTLND,BG0(54))	3333 663
EQUIVALENCE	3334 663
1(TRY0 ,BG0(55)),(TRY1 ,BG0(56)),(TRY2 ,BG0(57)),	3335 663
2(TRY3 ,BG0(58)),(TEST1 ,BG0(59)),(TOTLEN,BG0(60)),	3336 663
3(WHI ,BG0(61)),(WLO ,BG0(62)),(YIELD0,BG0(63)),	3337 663
4(YIELD1,BG0(64)),(YIELD2,BG0(65)),(NOINPT,BG0(66)),	3338 663
5(LIMPRS,BG0(67)),(PRTALL,BG0(68)),(OMAXD ,BG0(69)),	3339 663
6(OMAX,BG0(70)),(OMAX1,BG0(71)),(KOPTH,BG0(72)),	3340 663
7 (DMCONV,BG0(75)),(KDI,BG0(76)),(KDD,BG0(77)),(TRYMAX,BG0(	3341 663
878)),(MAXTMP,BG0(79)),(LMBULK,BG0(80)),(TBBULK,BG0(81)),	3342 663
9(KCHK1,BG0(1)),(KCHK2,BG0(7)),(KCHK3,BG0(18)),(KGAS,BG0(82))	3343 663
EQUIVALENCE(PDYIN,BG0(73)),(PDYEX,BG0(74)),(OMINLT,BG0(83)),	3344 663
1(OMEXIT,BG0(84)),(DPIN,BG0(85)),(DPEX,BG0(86))	3345 663
2,(TRANSF,BG0(87)),(TRANHL,BG0(88)),(TRANHU,BG0(89))	3346 663
3,(NEWSET,BG0(90)),(KTPAR,BG0(91)),(KTOTPR,BG0(92)),(QBAR,BG0(93)),	3347 663
4(QOQBAR,BG0(94)),(NOGEOM,BG0(95))	3348 663
EQUIVALENCE	3349 663
1(AFFD ,BG1(2)),(AFFI ,BG1(102)),(BSI ,BG1(202)),	3350 663
2(BSO ,BG1(213)),(BHIGH ,BG1(224)),(CLOSSI,BG1(237)),	3351 663
3(CLSGEN,BG1(337)),(CLSM DI,BG1(438)),(DHD ,BG1(539)),	3352 663
4(DHI ,BG1(639)),(DPARAM,BG1(739)),(DPARMI,BG1(747)),	3353 663
5(FTABI ,BG1(755)),(FPARMI,BG1(759)),(FMULTI,BG1(768)),	3354 663
6(GMASS ,BG1(868)),(HTABI ,BG1(968)),(HEDDUM,BG1(974)),	3355 663
7(HMULTI,BG1(987)),(KPARAM,BG1(1087)),(KPARMR,BG1(1095)),	3356 663

8(KRSCON,BG1(1103)),(NDH,BG1(1107)),(NAFL,BG1(1207)),	3357 663
9(NLEN,BG1(1307)),(NCLOSS,BG1(1407)),(NCLSMD,BG1(1507))	3358 663
EQUIVALENCE	3359 663
1(NHMULT,BG1(1607)),(NFMULT,BG1(1707)),(OLEND,BG1(1808)),	3360 663
2(OLENI,BG1(1908)),(PHISUM,BG1(2008)),(PHIEX,BG1(2108)),	3361 663
3(PO,BG1(2208)),(P1,BG1(2308)),(P2,BG1(2408)),	3362 663
4(TEXI,BG1(2508)),(TW,BG1(2608)),(XOLD,BG1(2708)),	3363 663
5(XOL,BG1(2808)),(REYNO,BG1(2908)),(FRIC,BG1(3008)),	3364 663
6(CONVEC,BG1(3108)),(DPINT,BG1(3208)),(OMEXI,BG1(3308))	3365 663
7,(PRTGAS,BG1(3408)),(PSEXI,BG1(3417)),(PDYEXI,BG1(3517))	3366 663
*OPEN AT 3617, KEEP OPEN UNTIL 3700	3367 663
DIMENSION KONOPT(2,10),KONPAR(4,13),SAVTAB(13,100),KSVTAB(13,100)	3368 663
EQUIVALENCE(KONOPT,KUP,BG2),(KONPAR,BG2(21)),	3369 663
1(SAVTAB,KSVTAB,BG2(73))	3370 663
*OPEN 1373	3371 663
EQUIVALENCE(THICKD,BG3(2)),(NRINGD,BG3(103)),(PEXI,BG3(203))	3372 663
*	3373 663
EQUIVALENCE(COFFLM,FTABI),(EXPFLM,FTABI(2)),(COFFTB,	3374 663
1FTABI(3)),(EXPFTB,FTABI(4))	3375 663
*	3376 663
*BASIC OPTIONAL VARIABLES	3377 663
DIMENSION GRTMPI(3),GRTMPO(3)	3378 663
EQUIVALENCE(PIN,BSI),(TIN,BSI(2)),(TEX,BSI(3)),(TWMAX,	3379 663
1BSI(4)),(PSEX,BSI(5)),(PEX,BSI(6)),(W,BSI(7)),(QTOT,	3380 663
2BSI(8)),(PIND,BSO),(TIND,BSO(2)),(TEXD,BSO(3)),(TWMAXD,	3381 663
3BSO(4)),(PSEXD,BSO(5)),(PEXD,BSO(6)),(WD,BSO(7)),(QTOTD,	3382 663
4BSO(8)),(PSXOPI,BSI(9)),(PTXOPI,BSI(10)),(TEXOTI,BSI(11)),	3383 663
5(PSPID,BSO(9)),(PTPID,BSO(10)),(TXTID,BSO(11)),	3384 663
6(GRTMPI,BSI(2)),(GRTMPO,BSO(2))	3385 663
*	3386 663
EQUIVALENCE(COFHLM,HTABI),(EXHPLM,HTABI(2)),(EXHRLM,	3387 663
1HTABI(3)),(COFHTE,HTABI(4)),(EXHPTB,HTABI(5)),(EXHRTB,	3388 663
2HTABI(6))	3389 663
EQUIVALENCE(DPTIN,DPARAM),(DTTIN,DPARAM(2)),(DTTEX,DPARAM(3)),	3390 663
1(DTWMAX,DPARAM(4)),(DPSEX,DPARAM(5)),(DPTEX,DPARAM(6)),(DW,DPARAM	3391 663
27)),(DQTOT,DPARAM(8)),(NOPTIN,KPARAM),	3392 663
3(NOTTIN,KPARAM(2)),(NOTTEX,KPARAM(3)),(NOTWMX,NTWMAX,NOTWA,	3393 663
4KPARAM(4)),(NOPSEX,KPARAM(5)),(NOPTEX,KPARAM(6)),(NOW,KPARAM(7)),	3394 663
5(NOQTOT,KPARAM(8))	3395 663
*	3396 663
* * * MASTER GROUPING	3397 663
DIMENSION BG0(100),BG1(3700),BG2(1372),BG3(302),	3398 663
1BG(5474)	3399 663
EQUIVALENCE(BG0,BG),(BG1,BG(101)),(BG2,BG(3801)),(BG3,BG(5173))	3400 663
COMMON BG	3401 663
* * * END OF MASTER GROUPING	3402 663
*	3403 663
EQUIVALENCE(KCHK11,KCHK2)	3404 663
*END OF STORAGE MAP	3405 663
*	3406 663
KDI=KDI	3407 663
*IS THIS ENTRY FOR CHOKE OR FOR YIELD IMPROVEMNT	3408 663
IF(KCHOKE)90,200,90	3409 663
90 CONTINUE	3410 663
*HAS THE CHOKE LIMIT BEEN EXCEEDED	3411 663
IF(LIMCHK-KTCHAD)100,100,110	3412 663
*HAS THIS CHOKE LIMIT BEEN PREVIOUSLY EXCEEDED	3413 663

100 IF(SENSE LIGHT 2)105,106	3414 663
105 SENSE LIGHT 2	3415 663
GO TO 300	3416 663
*EXCEEDED	3417 663
106 CALL NETERR(160,4)	3418 663
SENSE LIGHT 2	3419 663
GO TO 300	3420 663
*CONTINUE	3421 663
110 KTWTRY=0	3422 663
KWTTOT=0	3423 663
IF(TRYMAX)114,114,112	3424 663
112 WHI=MIN1F(WHI,TRYMAX)	3425 663
114 IF(KDI-1)120,116,120	3426 663
116 WLO=MAX1F(WLO,BSO(KDI))	3427 663
GO TO 150	3428 663
120 WHI=MIN1F(WHI,BSO(KDI))	3429 663
*	3430 663
150 KTCHAD=KTCHAD+1	3431 663
160 CONTINUE	3432 663
OMTRY=MIN1F(.9*OMINLT,.5*OMAX1)	3433 663
K2=KCHOKE	3434 663
IF(K2-1)170,170,180	3435 663
170 TD=TIND	3436 663
PD=PIND	3437 663
GO TO 190	3438 663
180 TD=TEXI(K2-1)	3439 663
PD=PEXI(K2-1)	3440 663
190 CONTINUE	3441 663
CALL FPRNT(6HCHKVAL,BSO(KDI),KCHOKE,1,KCHK11)	3442 663
AFF1=AFFI(K2)	3443 663
IF(KDI-1)194,192,194	3444 663
192 PIND=PRSFUN(AFF1,WD,TD,OMTRY,GAS)	3445 663
GO TO 196	3446 663
*FLOW FUNCTION AT M=0.1	3447 663
194 WD=FLWFUN(AFF1,PD,TD,OMTRY,GAS)	3448 663
196 CONTINUE	3449 663
CALL FPRNT(6HNEWFLO,BSO(KDI),KCHOKE,1,KCHK11)	3450 663
200 CONTINUE	3451 663
IF(BSO(KDI)-WLO)202,202,201	3452 663
201 IE(WHI-BSO(KDI))202,202,205	3453 663
202 BSO(KDI)=(WHI+WLO)/2.	3454 663
205 IF(KDI-1)206,214,206	3455 663
*SETUP FOR NEW WEIGHT FLOW	3456 663
206 DO 208 M=1,5	3457 663
IF(KOPT-2*M+1)208,210,208	3458 663
208 CONTINUE	3459 663
*TEXTD USER SPECIFIED	3460 663
GO TO 212	3461 663
*QTOTD USER-SPECIFIED	3462 663
210 TEXTD=TMPENT(QTOTD/WD+HIN,GAS,-1)	3463 663
212 DELH=TMPENT(TEXTD,GAS,1)-HIN	3464 663
DO 213 N=1,NOSTGE	3465 663
GMASS(N)=WD/AFFI(N)	3466 663
TEXI(N)=TMPENT(PHISUM(N)*DELH+HIN,GAS,-1)	3467 663
213 CONTINUE	3468 663
214 CONTINUE	3469 663
CALL FPRNT(6HNEWFLO,BSO(KDI),KTWTRY,1,KCHK11)	3470 663

KTWTRY=KTWTRY+1	3471 663
CALL DPFRLT(0)	3472 663
*DID CHOKE OCCUR	3473 663
IF(KCHOKE)250,250,215	3474 663
*CHOKE OCCURRED	3475 663
215 IF(KDI-1)218,216,218	3476 663
216 WLO=MAX1F(WLO,BSO(KDI))	3477 663
GO TO 219	3478 663
218 WHI=3SO(KDI)	3479 663
219 KTCHAD=KTCHAD+1	3480 663
*IS LIMIT EXCEEDED FOR SINGLE TRY	3481 663
IF(LIMCHK-KTCHAD)106,220,220	3482 663
220 IF(KDI-1)230,160,230	3483 663
*DID CHOKE MOVE DOWNSTREAM	3484 663
230 IF(KCHOKE-K2)200,200,160	3485 663
*NO CHOKE	3486 663
250 IF(KDI-1)251,260,251	3487 663
251 WLO=MAX1F(WLO,BSO(KDI))	3488 663
*IS MAX MACH NO MORE THAN OMAX1	3489 663
CALL FPRNT(6HMAXMNO,OMAX,KTWTRY,1,KCHK11)	3490 663
*ADJUST TO HIGHER FLOW IF MACH NO NOT ABOVE OMAX1	3491 663
255 IF(OMAX1-OMAX)270,256,256	3492 663
*DO WHI AND WLO DIFFER BY MORE THAN 1 PART IN 10-5	3493 663
256 IF(ABSF((WHI-WLO)/WHI)-1.E-5)270,270,257	3494 663
*HAVE 5 TRIES BEEN MADE WITH OMAX1	3495 663
257 IF(5 KTWTRY)258,258,200	3496 663
*DECREASE OMAX1	3497 663
258 OMAX1=.8*OMAX1	3498 663
KWTTOT=KWTTOT+KTWTRY	3499 663
KTWTRY=0	3500 663
CALL FPRNT(6HNEWMAX,OMAX1,KWTTOT,1,KCHK11)	3501 663
GO TO 255	3502 663
*UPDATE WHI FOR PRESSURE	3503 663
260 WHI=MIN1F(WHI,BSO(KDI))	3504 663
*FINISHED	3505 663
270 KCHOKE=0	3506 663
300 CONTINUE	3507 663
RETURN	3508 663
END(0,0,0)	3509 663

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* * * * * 3510 663
*GAM-D CP/CV 3511 663
* AIR(1)(APEX 527), H2(4)(DC 61-1-47), NEON(DC 58 6-205) 3512 663
* HELIUM(HE) APPROXIMATED FROM GE DESIGN DATA,G513.1,7/31/58 3513 663
  FUNCTION GAM(TD,GAS) 3514 663
  DIMENSION TMPLOW(4),TMPHI(4),A(6,4),TITLE(1),COFAIR(6), 3515 663
  1COFH2(6),COFN(6),COFHE(6) 3516 663
  EQUIVALENCE(COFAIR,A),(COFH2,A(7)),(COFN,A(13)),(COFHE,A(19)) 3517 663
  TABLE TMPLOW(500.,180.,0.,0.),TMPHI(2900.,4400.,1.+20,1.+20) 3518 663
  TABLE 3519 663
  1COFAIR(1.3817485,1.0502408E-04,-1.6293016E-07,6.5723018E-11, 3520 663
  2-8.6452813E-15,0.) 3521 663
  3,COFH2(1.44,-.03545E-03,0.,0.,0.,0.) 3522 663
  4,COFN(1.651,0.,0.,0.,0.,0.) 3523 663
  5,COFHE(1.667,0.,0.,0.,0.,0.) 3524 663
  6,TITLE(3HGAM) 3525 663
  EXCEED=0. 3526 663
  KGAS=GAS 3527 663
  KGAST=KGAS 3528 663
  T=TD 3529 663
  GO TO (100,10,10,400,10,600,10,10,900),KGAS 3530 663
10 CALL NOPROP(TITLE,KGAS) 3531 663
*AIR 3532 663
  100 KGASD=1 3533 663
  KGAST=1 3534 663
  GO TO 2000 3535 663
*H2 3536 663
  400 KGASD=2 3537 663
  GO TO 2000 3538 663
*HE 3539 663
  600 KGASD=4 3540 663
  GO TO 2000 3541 663
*NEON 3542 663
  900 KGASD=3 3543 663
*CHECK LIMITS 3544 663
  2000 IF(T TMPLOW(KGASD))2005,2020,2010 3545 663
  2005 T=TMPLOW(KGASD) 3546 663
  GO TO 2016 3547 663
  2010 IF(TMPHI(KGASD)-T)2015,2020,2020 3548 663
  2015 T=TMPHI(KGASD) 3549 663
  2016 EXCEED=1. 3550 663
  2020 GAM= 3551 663
  1 A(1,KGASD)+T*(A(2,KGASD)+T*(A(3,KGASD)+T*(A(4,KGASD) 3552 663
  2+T*(A(5,KGASD) T*A(6,KGASD)))) 3553 663
*WAS TEMP LIMIT EXCEEDED 3554 663
  3000 IF(EXCEED)3010,3020,3010 3555 663
  3010 CALL LMPROP(TITLE,TMPLOW(KGASD),TMPHI(KGASD),TD,KGAST) 3556 663
*FINISHED 3557 663
  3020 CONTINUE 3558 663
  RETURN 3559 663
  END(0,1,0) 3560 663
* * * * * 3561 663
*LMPROP SR TO PRINT COMMENT WHEN TEMP LIMITS FOR 225 3562 663

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* FOR PROPERTY FUNCTIONS ARE EXCEEDED 3563 663
*USEAGE - CALL LMPROP(NAME(HOLLERITH),TLOW,THIGH,T TRIED, 3564 663
* KGAS) 3565 663
* S C SKIRVIN 3566 663
* 3567 663
SUBROUTINE LMPROP(NAME,TLOW,THIGH,TRIED,KGAS) 3568 663
* 3569 663
DIMENSION PRTGSL(9) 3570 663
TABLE PRTGSL(54HAIR N2 CO2 H2 O2 HE ARGON FREON NE 3571 663
1ON ) 3572 663
WRITE OUTPUT TAPE 3,32000,NAME,PRTGSL(KGAS), 3573 663
1TLOW,THIGH,TRIED 3574 663
* LMPROP 3575 663
32000 FORMAT 3576 663
SPACE 3577 663
* * * * * 3578 663
*-X -A TMP-LIMITS FOR-X -A ARE -FO AND -FO (DEG R) 3579 663
* T= -FO WAS TRIED, BUT NEAREST LIMIT TEMP WAS USED. 3580 663
* * * * * 3581 663
SPACE 3582 663
END OF FORMAT 3583 663
RETURN 3584 663
END(0,1,0) 3585 663
* * * * * 3586 663
*NOPROP A SR FOR PRINTOUT REGARDING MISSING 3587 663
* GAS PROPERTIES 3588 663
*USEAGE - CALL NOPROP(HOLLERITH(MAX 6 CHARAC),KGAS(FIXED 3589 663
* POINT)) 3590 663
* 3591 663
SUBROUTINE NOPROP(COM,KGAS) 3592 663
TABLE PRTGSL(54HAIR N2 CO2 H2 O2 HE ARGON FREON NE 3593 663
1ON ) 3594 663
DIMENSION PRTGSL(9) 3595 663
WRITE OUTPUT TAPE 3,32000,COM,PRTGSL(KGAS),KGAS 3596 663
32000 FORMAT 3597 663
SPACE 2 3598 663
* * * * * 3599 663
*GAS PROPERTY-X -A NOT PRESENT FOR-X -A(NO -I). AIR VALUE ASSUMED 3600 663
* * * * * 3601 663
END OF FORMAT 3602 663
* 3603 663
RETURN 3604 663
END(0,1,0) 3605 663
*PRN-D PRANDTL NO 3606 663
*AIR(1)(APEX 527),NEON(9)(DC 58-6-205),H2(4)(DC 61 1-47) 3607 663
* HELIUM(HE) APPROXIMATED FROM GE DESIGN DATA,G513.1,7/31/58 3608 663
FUNCTION PRN(TD,GAS) 3609 663
DIMENSION TMPLOW(4),TMPHI(4),A(6,4),TITLE(1),COFAIR(6), 3610 663
1COFH2(6),COFN(6),COFHE(6) 3611 663
EQUIVALENCE(COFAIR,A),(COFH2,A(7)),(COFN,A(13)),(COFHE,A(19)) 3612 663
TABLE TMPLOW(400.,180.,460.,860.),TMPHI(2400.,3600.,2800.,1.+20), 3613 663
1COFAIR(9.970762E-1,-9.64461E-4,1.042408E-6,-4.920634E-10, 3614 663
21.046379E-13,-7.659388E-18) 3615 663
3,COFH2(9.361730E-1,-6.592753E-4,4.622303E-7, 8.246998E 11, 3616 663
44.312456E-16,0.) 3617 663
5,COFN(1.2773,1.8416E-3,2.1338E-6,-1.1991E-9,3.2599E-13, 3618 663
6-3.4314E-17); 3619 663

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7COFHE(.72,0.,0.,0.,0.,0.),TITLE(3HPRN)	3620	663
EXCEED=0.	3621	663
KGAS=GAS	3622	663
KGAST=KGAS	3623	663
T=TD	3624	663
GO TO (100,10,10,400,10,600,10,10,900),KGAS	3625	663
10 CALL NOPROP(TITLE,KGAS)	3626	663
*AIR	3627	663
100 KGASD=1	3628	663
KGAST=1	3629	663
GO TO 2000	3630	663
*H2	3631	663
400 KGASD=2	3632	663
GO TO 2000	3633	663
*HE	3634	663
600 KGASD=4	3635	663
GO TO 2000	3636	663
*NEON	3637	663
900 KGASD=3	3638	663
*CHECK LIMITS	3639	663
2000 IF(T TMPLOW(KGASD))2005,2020,2010	3640	663
2005 T=TMPLOW(KGASD)	3641	663
GO TO 2016	3642	663
2010 IF(TMPHI(KGASD)-T)2015,2020,2020	3643	663
2015 T=TMPHI(KGASD)	3644	663
2016 EXCEED=1.	3645	663
2020 PRN=	3646	663
1 A(1,KGASD)+T*(A(2,KGASD)+T*(A(3,KGASD)+T*(A(4,KGASD)	3647	663
2+T*(A(5,KGASD)+T*(A(6,KGASD))))	3648	663
*WAS TEMP LIMIT EXCEEDED	3649	663
3000 IF(EXCEED)3010,3020,3010	3650	663
3010 CALL LMPROP(TITLE,TMPLOW(KGASD),TMPHI(KGASD),TD,KGAST)	3651	663
*FINISHED	3652	663
3020 CONTINUE	3653	663
RETURN	3654	663
END(0,1,0)	3655	663
* * * * *	3656	663
CR USEAGE R(NUMBER INDICATES THE GAS)	3657	663
FUNCTION R(GAS)	3658	663
NGAS=GAS	3659	663
GO TO(1,2,3,4,5,6,7,8,9),NGAS	3660	663
CGAS =1,AIR	3661	663
1 R=53.35	3662	663
GO TO 100	3663	663
CGAS =2,NITROGEN(2)	3664	663
2 R=55.112	3665	663
GO TO 100	3666	663
CGAS =3,CARBON DIOXIDE	3667	663
3 R=35.082	3668	663
GO TO 100	3669	663
CGAS =4,HYDROGEN(2)	3670	663
4 R=765.873	3671	663
GO TO 100	3672	663
CGAS =5,OXYGEN(2)	3673	663
5 R=48.25	3674	663
GO TO 100	3675	663
CGAS =6,HELIUM	3676	663

6 R=385.711	3677 663
GO TO 100	3678 663
IGAS =7, ARGON	3679 663
7 R=38.654	3680 663
GO TO 100	3681 663
IGAS =8, FREON	3682 663
8 R=15.1484	3683 663
GO TO 100	3684 663
*NEON	3685 663
9 R=76.6	3686 663
100 RETURN	3687 663
END(0,1,0)	3688 663
* * * * *	3689 663
* * * * *	3690 663
*TC-D	3691 663
* AIR(1)(APEX 527), H2(4)(DC 61-1-47), NEON(DC 58 6-205)	3692 663
* HELIUM(HE) APPROXIMATED FROM GE DESIGN DATA,G513.1,7/31/58	3693 663
FUNCTION TC(TD,GAS)	3694 663
DIMENSION TMPLOW(4),TMPHI(4),A(6,4),TITLE(1),COFAIR(6),	3695 663
1COFH2(6),COFN(6),COFHE(6)	3696 663
EQUIVALENCE(COFAIR,A),(COFH2,A(7)),(COFN,A(13)),(COFHE,A(19))	3697 663
TABLE TMPLOW(100.,180.,460.,660.),TMPHI(3800.,3600.,2800.,1760.)	3698 663
TABLE	3699 663
1COFAIR(-2.6073866E-08,8.3542893E-10,-2.970625E-13,8.7701180E-17,	3700 663
2-14.653178E-21,10.162822E-25)	3701 663
3,COFH2(1.7508833E-07,4.9717133E-09,-7.9260066E-13,-4.7760366E-16,	3702 663
41.5687925E-19, 4.6325091E-24)	3703 663
5,COFN(-2.9599169E-07,2.421E-09,1.902E-12,9.9E-16,-2.6303335E-19,	3704 663
62.74866667E-23)	3705 663
7,COFHE(1.13E-06,1.77E-09,0.,0.,0.,0.)	3706 663
8,TITLE(2HTC)	3707 663
EXCEED=0.	3708 663
KGAS=GAS	3709 663
KGAST=KGAS	3710 663
T=TD	3711 663
GO TO (100,10,10,400,10,600,10,10,900),KGAS	3712 663
10 CALL NOPROP(TITLE,KGAS)	3713 663
AIR	3714 663
100 KGASD=1	3715 663
KGAST=1	3716 663
GO TO 2000	3717 663
H2	3718 663
400 KGASD=2	3719 663
GO TO 2000	3720 663
HE	3721 663
600 KGASD=4	3722 663
GO TO 2000	3723 663
NEON	3724 663
900 KGASD=3	3725 663
CHECK LIMITS	3726 663
2000 IF(T TMPLOW(KGASD))2005,2020,2010	3727 663
2005 T=TMPLOW(KGASD)	3728 663
GO TO 2016	3729 663
2010 IF(TMPHI(KGASD)-T)2015,2020,2020	3730 663
2015 T=TMPHI(KGASD)	3731 663
2016 EXCEED=1.	3732 663
2020 TC=	3733 663

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1      A(1,KGASD)+T*(A(2,KGASD)+T*(A(3,KGASD)+T*(A(4,KGASD)
2+T*(A(5,KGASD)+T*(A(6,KGASD))))))
*WAS TEMP LIMIT EXCEEDED
3000 IF(EXCEED)3010,3020,3010
3010 CALL LMPROP(TITLE,TMPLOW(KGASD),TMPHI(KGASD),TD,KGAST)
*FINISHED
3020 CONTINUE
      RETURN
      END(0,1,0)
* * * * *
CTMPENT-A FUNCTION TO CALC ENTHALPY FROM TEMP OR
* TEMP FROM ENTHALPY
*AIR(1),N2(2),CO2(3),H2(4),O2(5),HE(6),ARGON(7),FREON(8),NEON(9)
*AIR - BASED ON ANPD AIR PROPERTIES DATA BOOK(APEX )
*H2 BASED ON NASA DATA(KING TN D-275, 441 PSIA)
* HELIUM(HE) APPROXIMATED FROM GE DESIGN DATA,G513.1,7/31/58
* S C SKIRVIN
*USEAGE - FUNCTION TMPENT(TEMP OR ENTHALPY,GAS SELECTOR,
* MODE) - (GAS SELECTOR IS FLOATING POINT)
* MODE= 1 MEANS ENTHALPY FROM TEMP, MODE=-1 MEANS
* TEMP FROM ENTHALPY (TEMPS IN DEG R)
*
      FUNCTION TMPENT(VD,GAS,MODE)
*
      TABLE ATGR(
10.,.240176,-8.005646-6,1.192176-8, 2.917016-12,2.340132-16,0.,0.,
20.,0.,0.,0.,0.,0.,0.,0.,0.,
30.,0.,0.,0.,0.,0.,0.,0.,0.,
459938.,4460.08 3,-1657.-6,904.55-9,-190.42-12,14.381-15,0.,0.,
50.,0.,0.,0.,0.,0.,0.,0.,0.,
60.,0.,0.,0.,0.,0.,0.,0.,0.,
70.,0.,0.,0.,0.,0.,0.,0.,0.,
80.,0.,0.,0.,0.,0.,0.,0.,0.,
9-5.39,.2484,0.,0.,0.,0.,0.,0.,0.,)
      TABLE CTDGR(
1-1.6011292-5,3.576528-8, 1.1668064 11,1.170066-15,0.,0.
20.,0.,0.,0.,0.,0.,0.,0.,
30.,0.,0.,0.,0.,0.,0.,0.,
4-3314.-6,2713.65-9,-761.68-12,71.905-15,0.,0.,
50.,0.,0.,0.,0.,0.,0.,0.,
60.,0.,0.,0.,0.,0.,0.,0.,
70.,0.,0.,0.,0.,0.,0.,0.,
80.,0.,0.,0.,0.,0.,0.,0.,
90.,0.,0.,0.,0.,0.,0.,0.)
      TABLE AHGR(
10.,4.183639,4.440606-4,-3.284583-6,3.74104-9,-1.3759926-12,0.,0.,
20.,0.,0.,0.,0.,0.,0.,0.,
30.,0.,0.,0.,0.,0.,0.,0.,
4-39828.,11855. 4,-1228.2 8,66.243-12,-.5738-16,-.09086 20,0.,0.,
50.,0.,0.,0.,0.,0.,0.,0.,
60.,0.,0.,0.,0.,0.,0.,0.,
70.,0.,0.,0.,0.,0.,0.,0.,
80.,0.,0.,0.,0.,0.,0.,0.,
90.,0.,0.,0.,0.,0.,0.,0.)
      DIMENSION ATGR(8,9),CTDGR(6,9),AHGR(8,9),ATS(8),
1CTDS(6),AHS(8)
      EQUIVALENCE(AT,ATS),(BT,ATS(2)),(CT,ATS(3)),(DT,ATS(4)),

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1(ET,ATS(5)),(FT,ATS(6)),(GT,ATS(7)),(HT,ATS(8)),(CTD,CTDS),	3791 663
2(DTD,CTDS(2)),(ETD,CTDS(3)),(FTD,CTDS(4)),(GTD,CTDS(5)),	3792 663
3(HTD,CTDS(6)),(AH,AHS),(BH,AHS(2)),(CH,AHS(3)),(DH,AHS(4)),	3793 663
4(EH,AHS(5)),(FH,AHS(6)),(GH,AHS(7)),(HH,AHS(8))	3794 663
*	3795 663
V=VD	3796 663
T=V	3797 663
KGAS=GAS	3798 663
MD=MODE	3799 663
*CHECK IF FIRST ENTRY FOR MACHINE RUN	3800 663
IF(KGAS-6)20,410,20	3801 663
20 IF(IFIRST-9999)90,30,90	3802 663
*CHECK IF SAME GAS AS LAST ENTRY	3803 663
30 IF(KGAS-LSTGAS)90,40,90	3804 663
*CHECK IF SAME MODE AS LAST ENTRY	3805 663
40 IF(LSTMDE-MD)50,50,90	3806 663
*IF +,SET INVERSION CONSTANTS IF MINUS, ALREADY HAVE	3807 663
* CONSTANTS - IF ZERO, NO CHANGE FROM PREVIOUS ENTRY	3808 663
50 IF(MD)300,310,310	3809 663
*FIRST CHECK IF GAS PRESENT	3810 663
90 IF(9 KGAS)100,95,95	3811 663
95 GO TO(110,100,100,110,100,100,100,110),KGAS	3812 663
*ERROR COMMENT	3813 663
100 CALL NOPROP(6HTMPENT,KGAS)	3814 663
KGAS=1	3815 663
*SELECT GAS CONSTANTS	3816 663
110 DO 120 L=1,8	3817 663
ATS(L)=ATGR(L,KGAS)	3818 663
120 CONTINUE	3819 663
IF(MD)130,310,310	3820 663
*SET CONSTANTS FOR INVERSION	3821 663
130 DO 150 L=1,8	3822 663
*FIRST CUT COEFFICIENTS	3823 663
AHS(L)=AHGR(L,KGAS)	3824 663
IF(6 L)150,140,140	3825 663
*DERIVATIVE COEFFICIENTS	3826 663
140 CTDS(L)=CTDGR(L,KGAS)	3827 663
150 CONTINUE	3828 663
*	3829 663
*BEGIN CALCULATIONS	3830 663
*FIRST ENTRY FOR ITERATION - FIRST TEMP CUT	3831 663
300 T=V*(V*(V*(V*(V*(V*HH GH)+FH)+EH)+DH)+CH) BH)+AH	3832 663
*SET ENTHALPY FIRST CUT	3833 663
310 HO=T*(T*(T*(T*(T*(T*(T*HT+GT)+FT)+ET)+DT)+CT)+BT)+AT	3834 663
IF(MD)320,340,340	3835 663
*IF POS, ONLY WANTED ENTHALPY AND IS THRU	3836 663
320 HO=HO-V	3837 663
DHDTO=T*(T*(T*(T*(T*(T*HTD+GTD)+FTD)+ETD)+DTD)	3838 663
1+CTD)+BT	3839 663
TMPENT=T-HO/DHDTO	3840 663
IF(ABS(TMPENT T)-.049999)350,350,330	3841 663
*NEW PASS	3842 663
330 T=TMPENT	3843 663
GO TO 310	3844 663
*FINISHED, MODE=1 FIRST	3845 663
340 TMPENT=HO	3846 663
*MODE=-1	3847 663

350 CONTINUE	3848 663
*SET SAVER TRIGGERS	3849 663
IFIRST=9999	3850 663
LSTGAS=KGAS	3851 663
LSTMDE=MD	3852 663
GO TO 400	3853 663
410 IF(MD)430,400,420	3854 663
*HE	3855 663
420 TMPENT=1.242*V	3856 663
GO TO 400	3857 663
430 TMPENT=.805*V	3858 663
*FINISHED	3859 663
400 CONTINUE	3860 663
RETURN	3861 663
END(0,1,0)	3862 663
* * * * *	3863 663
*VISC-D VISCOSITY-LBM/SEC-FT	3864 663
* AIR(1)(APEX 527), H2(4)(DC 61-1-47), NEON(DC 58 6-205)	3865 663
* HELIUM(HE) APPROXIMATED FROM GE DESIGN DATA,G513.1,7/31/58	3866 663
FUNCTION VISC(TD,GAS)	3867 663
DIMENSION TMPLOW(4),TMPHI(4),COFVIS(6,4),A(6,4)	3868 663
EQUIVALENCE(A,COFVIS)	3869 663
TABLE TMPLOW(500.,180.,460.,660.),TMPHI(2900.,4400.,2800.,1760.),	3870 663
1COFVIS(23.25E-07,.21365E 07,-5.004E-12,6.967E-16,-2.588E-20,	3871 663
20.,	3872 663
30.,10.8264E-09,-1.96298E 12,.16358E-15,0.,0.,	3873 663
43.5412E-07,5.5814E-08,-4.3736E-11,2.6390E-14,-8.1457E-18,	3874 663
59.7400E-22,8.40E-06,11.8E-09,0.,0.,0.,0.),TITLE(4HVISC)	3875 663
*	3876 663
EXCEED=0.	3877 663
KGAS=GAS	3878 663
T=TD	3879 663
GO TO (100,10,10,400,10,600,10,10,900),KGAS	3880 663
10 CALL NOPROP(TITLE,KGAS)	3881 663
*AIR	3882 663
100 KGASD=1	3883 663
GO TO 2000	3884 663
*H2	3885 663
400 KGASD=2	3886 663
GO TO 2000	3887 663
*HE	3888 663
600 KGASD=4	3889 663
GO TO 2000	3890 663
*NEON	3891 663
900 KGASD=3	3892 663
*CHECK LIMITS	3893 663
2000 IF(T TMPLOW(KGASD))2005,2020,2010	3894 663
2005 T=TMPLOW(KGASD)	3895 663
GO TO 2016	3896 663
2010 IF(TMPHI(KGASD)-T)2015,2020,2020	3897 663
2015 T=TMPHI(KGASD)	3898 663
2016 EXCEED=1.	3899 663
2020 VISC=A(1,KGASD)+T*(A(2,KGASD)+T*(A(3,KGASD)+T*(A(4,KGASD)	3900 663
1+T*(A(5,KGASD) T*A(6,KGASD))))	3901 663
*WAS TEMP LIMIT EXCEEDED	3902 663
3000 IF(EXCEED)3010,3020,3010	3903 663
3010 CALL LMPROP(TITLE,TMPLOW(KGASD),TMPHI(KGASD),TD,KGAS)	3904 663

*FINISHED
3020 CONTINUE
RETURN
END(0,1,0)

3905 663
3906 663
3907 663
3908 663

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* * * * * 3909 663
*AMACH 3910 663
CUSEAGE AMACH(INITIAL GUESS,W/A,P,T,ACCURACY(FRACTIONAL),GAS) 3911 663
      FUNCTION AMACH(OMACHB,G,P,T,PER,GAS) 3912 663
      OMACHD=OMACHB 3913 663
      5 GAMY=GAM(T,GAS) 3914 663
      C1=(GAMY-1.0)/2.0 3915 663
      C2=(GAMY+1.0)/(2.0*(GAMY 1.0)) 3916 663
      C3=(G/P)*SQRTF(R(GAS)*T/(32.17*GAMY)) 3917 663
      10 VAR=1.0+C1*OMACHD**2 3918 663
      F=(C3*VAR**C2) OMACHD 3919 663
      FPRIME=C3*(GAMY+1.0)*OMACHD/(2.0*VAR**(1.0-C2))-1.0 3920 663
      OMACH=OMACHD-F/FPRIME 3921 663
      IF(OMACH-.99)20,30,30 3922 663
      20 IF(ABSF((OMACH OMACHD)/OMACH)-PER)30,25,25 3923 663
      25 OMACHD=OMACH 3924 663
      GO TO 10 3925 663
      30 AMACH=OMACH 3926 663
      RETURN 3927 663
      END(0,1,0) 3928 663
* * * * * 3929 663
CCONTMP SR TO CONVERT NON-ZERO TEMPS FROM R TO F OR VICE VERSA 3930 663
* SETS ZERO R TEMPS = -9999. 3931 663
*NEGATIVE TEMPS ARE ASSUMED TO BE IN DEG F 3932 663
* 11/23/60 3933 663
* S C SKIRVIN 3934 663
*USEAGE-CALL CONTMP(SOURCE TABLE,FINAL TABLE,NO OF 3935 663
* ENTRIES,MODE OF CHANGE) 3936 663
*MODE. =+1 F TO R, =-1 R TO F 3937 663
      SUBROUTINE CONTMP(ST,NO,ET,MODE) 3938 663
      DIMENSION ST(2),ET(2) 3939 663
      IF(MODE)100,100,110 3940 663
      100 KRT=1 3941 663
      GO TO 120 3942 663
      110 KRT=2 3943 663
      120 DO 190 M=1,NO 3944 663
      IF(ST(M))180,140,160 3945 663
      140 GO TO(150,190),KRT 3946 663
      150 ET(M)=-9999. 3947 663
      GO TO 190 3948 663
      160 GO TO(170,180),KRT 3949 663
      170 ET(M)=ST(M)-460. 3950 663
      GO TO 190 3951 663
      180 ET(M)=ST(M)+460. 3952 663
      190 CONTINUE 3953 663
*FINISHED 3954 663
      200 CONTINUE 3955 663
      RETURN 3956 663
      END(0,0,0) 3957 663
* * * * * 3958 663
CDSTRB1 A SR FOR SPOTTING AND DISTRIBUTION WITHOUT UNIT 3959 663
*CHANGES 3960 663
* * CONNET(ANP 622) * * 3961 663

```

* S C SKIRVIN	3962 663
* USEAGE CALL DSTRB1(SOURCE TABLE,NO. OF SOURCE	3963 663
*ENTRIES,RECEIVING TABLE,DISTRIBUTING VARIABLE(FIXED POINT),	3964 663
*CONTROL(FIXED POINT),SIGNAL IF DISTRIBUTION DONE)	3965 663
* CONTROL,=0 NON ZERO POINT-FOR-POINT SHIFT,=1 TAKE	3966 663
*DISTRIBUTE ENTRIES ONE AT A TIME,=2 TAKE DISTRIBUTE	3967 663
*ENTRIES TWO AT A TIME AND DISTRIBUTE FROM SOURCE	3968 663
*INTO RECEIVER.	3969 663
* SIGNAL,=0 IF NO DISTRIBUTION,=1 IF DISTRIBUTION.	3970 663
* S C SKIRVIN 9/20/60	3971 663
SUBROUTINE DSTRB1(SOURCE,NOSOR,RECEIV,KDISTR,ITYPE,KSIG)	3972 663
DIMENSION SOURCE(500),RECEIV(500),KDISTR(1000)	3973 663
KSIG=0	3974 663
IF(ITYPE)100,200,100	3975 663
*NOT SIMPLE TRANSFER OF NON-ZERO QUANTITIES	3976 663
100 IF(1 NOSOR)110,120,120	3977 663
*TEST IF KDISTR PRESENT FOR NON-SIMPLE TRANSFER	3978 663
110 IF(KDISTR(1))230,230,120	3979 663
120 DO 190 N=1,1000,ITYPE	3980 663
*TEST IF FINISHED	3981 663
IF(KDISTR(N))230,230,130	3982 663
130 KL=KDISTR(N)	3983 663
KSIG=1	3984 663
*TEST IF POINT-FOR POINT SHIFT OR DISTRIBUTION	3985 663
IF(ITYPE-1)180,180,140	3986 663
*DISTRIBUTION	3987 663
140 KU=KDISTR(N+1)	3988 663
DO 170 K=KL,KU	3989 663
*TEST IF SINGLE-ENTRY OR MULTIPLE ENTRY SOURCE	3990 663
IF(NOSOR-1)150,150,160	3991 663
*SINGLE ENTRY	3992 663
150 RECEIV(K)=SOURCE(1)	3993 663
GO TO 170	3994 663
*MULTIPLE-ENTRY	3995 663
160 RECEIV(K)=SOURCE(KL)	3996 663
170 CONTINUE	3997 663
GO TO 190	3998 663
*POINT-FOR POINT SHIFT	3999 663
180 RECEIV(KL)=SOURCE(1)	4000 663
*LOOP END	4001 663
190 CONTINUE	4002 663
GO TO 230	4003 663
*SIMPLE TRANSFER	4004 663
200 DO 220 N=1,NOSOR	4005 663
*TEST TO INSURE NON-ZERO SHIFT	4006 663
IF(SOURCE(N))210,220,210	4007 663
210 RECEIV(N)=SOURCE(N)	4008 663
220 CONTINUE	4009 663
*SUBROUTINE END	4010 663
230 RETURN	4011 663
END(0,1,0)	4012 663
* * * * *	4013 663
CDYPRSGAS	4014 663
FUNCTION DYPRS(G,P,T,AMACH,GAS)	4015 663
C CALCULATES COMPRESSIBLE DYNAMIC PRESS IN PSI OR	4016 663
C PSF, DEPENDING ON CONSISTENT INPUT UNITS	4017 663
C USEAGE DYPRS(MASS VEL,TOTAL PRESS,TOTAL TEMP,MACH	4018 663


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C      NO,GAS SELECTOR)                                4019 663
      GAMA=GAM(T,GAS)                                4020 663
      DYPRS=(R(GAS)*(G**2*T/P)*(1.+(GAMA 1.)/2.*      4021 663
      1AMACH**2)**(1./(GAMA-1.)))/64.34              4022 663
      RETURN                                           4023 663
      END(0,0,0)                                       4024 663
* * * * *                                           4025 663
*EXTRAP  A SR TO DO 2 OR 3-POINT EXTRAPOLATION      4026 663
*  S C SKIRVIN                                       4027 663
*    3/21/61                                         4028 663
*USEAGE - CALL EXTRAP(X0,Y0,X1,Y1,X2,Y2,X3(NEXT TRY), 4029 663
*  Y3(DESIRED YIELD),NO(2 OR 3, WHETHER 2 OR 3 POINT 4030 663
*  FIT WANTED))                                       4031 663
*MODEL - (Y-B)**2=4.*F(X-A) FOR 3-POINT, Y=AX+B     4032 663
*  FOR 2-POINT                                       4033 663
*    AUTOMATICALLY DOES 2-POINT WITH X1,Y1,X2,Y2, IF 4034 663
*    DIVIDE CHECK ENCOUNTERED DURING 3 PT FIT      4035 663
*                                                    4036 663
      SUBROUTINE EXTRAP(X0,Y0,X1,Y1,X2,Y2,X3,Y3,NO)   4037 663
*                                                    4038 663
*SELECT FIT                                           4039 663
      IF(NO-2)300,200,100                             4040 663
*3-POINT                                             4041 663
  100 Y2M0=Y2-Y0                                       4042 663
      Y2P0=Y2+Y0                                       4043 663
      Y1M0=Y1-Y0                                       4044 663
      Y1P0=Y1+Y0                                       4045 663
      X2M0=X2-X0                                       4046 663
      X1M0=X1-X0                                       4047 663
      B=(Y2M0*Y2P0*X1M0-Y1M0*Y1P0*X2M0)/             4048 663
      1(2.*(Y2M0*X1M0 Y1M0*X2M0))                   4049 663
      IF DIVIDE CHECK 200,110                         4050 663
  110 FT4=(Y2M0*Y2P0 2.*B*Y2M0)/X2M0                 4051 663
      IF DIVIDE CHECK 200,120                         4052 663
  120 A=X2 ((Y2-B)**2/FT4)                             4053 663
      IF DIVIDE CHECK 200,130                         4054 663
  130 X3=A ((Y3-B)**2/FT4)                             4055 663
      GO TO 300                                       4056 663
*2-POINT                                             4057 663
  200 X3=((X2-X1)/(Y2-Y1))*(Y3 Y2)+X2                 4058 663
*FINISHED                                           4059 663
  300 CONTINUE                                       4060 663
      RETURN                                           4061 663
      END(0,1,0)                                       4062 663
* * * * *                                           4063 663
CFLWFUN  A FUNCTION WHICH EVALUATES THE COMPRESSIBLE FLOW FUNCTION 4064 663
*  IN TERMS OF TOTAL PROPERTIES - UNITS ARE INCH-BASED AND DEG R 4065 663
      FUNCTION FLWFUN(AFF,P,T,OM,GAS)                 4066 663
      GAMA=GAM(T,GAS)                                4067 663
      FLWFUN  =AFF      *OM*P      *SQRTF((32.17*    4068 663
      1GAMA)/(R(GAS)*T      ))/((1.+(GAMA-1.)/2.)*OM**2) 4069 663
      2**(((GAMA+1.)/(2.*(GAMA-1.))))               4070 663
      RETURN                                           4071 663
      END(0,0,0)                                       4072 663
* * * * *                                           4073 663
*FPRNT    SUBROUTINE TO PRINT FLOATING POINT VAR.    4074 663
      SUBROUTINE FPRNT(P,V,N,K)

```

DIMENSION V(500)	4076 663
IF(K)5,5,10	4077 663
5 IF(SENSE SWITCH 5)10,20	4078 663
10 WRITE OUTPUT TAPE 3,1000,B,J,(V(K),K=1,N)	4079 663
1000 FORMAT(6H0 A6,I3/(1P4E15.5))	4080 663
20 RETURN	4081 663
END(0,1,0)	4082 663
* * * * *	4083 663
LOSS SR TO CALCULATE NON-FRICTIONAL TOTAL PRESSURE LOSSES	4084 663
THIS VERSION HAS ONLY INCOMPRESSIBLE EXPANSION AND	4085 663
CONTRACTION LOSSES BASED ON DF56AGT588(EXP) AND	4086 663
DF56AGT468(CONTRAC)	4087 663
J E STANKEVICZ	4088 663
	4089 663
SUBROUTINE LOSS(A1,A2,L,DIMA,DIMB,DIMC,THETA,CLOSS)	4090 663
	4091 663
USEAGE (A1=STA 1 AREA,A2=STA 2 AREA,L=TYPE OF	4092 663
LOSS,NEXT 4 VARIABLES CAN HAVE VARIOUS USES,	4093 663
CLOSS=CALCULATED COEFFICIENT)	4094 663
2000 FORMAT	4095 663
SPACE	4096 663
LOSS SUBROUTINE HAS MAX SELECTION OF 4 IN THIS VERSION.	4097 663
PROGRAM ASKED FOR -I. CHECK WITH J STANKEVICZ OR	4098 663
S SKIRVIN FOR LATER, EXPANDED VERSION.	4099 663
SPACE	4100 663
END OF FORMAT	4101 663
IF(L 4)10,10,20	4102 663
10 GO TO (1,2,3,4),L	4103 663
1 INDICATES CONTRACTION BASED ON Q1	4104 663
1 SIG=A2/A1	4105 663
PSI=1.0-((2.0+SIG)/5.1415927)*SQRTF(1.0-SIG)	4106 663
CLOSS=((1.0/PSI-1.0)/SIG)**2	4107 663
GO TO 100	4108 663
2 INDICATES CONTRACTION BASED Q2	4109 663
2 SIG=A2/A1	4110 663
PSI=1.0-((2.0+SIG)/5.1415927)*SQRTF(1.0-SIG)	4111 663
CLOSS=(1.0/PSI 1.0)**2	4112 663
GO TO 100	4113 663
3 INDICATES EXPANSION BASED ON Q1	4114 663
3 CLOSS=(1.0-A1/A2)**2	4115 663
GO TO 100	4116 663
4 INDICATES EXPANSION BASED ON Q2	4117 663
4 CLOSS=(A2/A1-1.0)**2	4118 663
GO TO 100	4119 663
20 WRITE OUTPUT TAPE 3,32000,L	4120 663
SENSE LIGHT 2	4121 663
CLOSS=0.	4122 663
100 RETURN	4123 663
END(0,1,0)	4124 663
* * * * *	4125 663
NTERR622 SR TO PRINT ERROR COMMENTS FOR	4126 663
* COMNET(ANP 622) * *	4127 663
S C SKIRVIN	4128 663
10/6/60	4129 663
SUBROUTINE NETERR(N,LOC)	4130 663
WRITE OUTPUT TAPE 3,32000,N,LOC	4131 663
2000 FORMAT	4132 663

```

SPACE 2
* * * * *
* CALCULATION TERMINATED BY TYPE -I ERROR AT LOC -I * * *
* * * * *
END OF FORMAT
RETURN
END(0,1,0)
* * * * *
CPOWER3 A SR TO CARRY OUT INTEGRATION OF POWER PROFILES. NOT SAME CALL
* STATEMNT AS POWER2A, BUT IS STRIPPED FOR MINIMUM MEMORY AND DOES NOT
* PUNCH, PRINT, OR NORMALIZE POWER PROFILES
C USAGE CALL POWER3(TRAILING EDGE FACTORS, ACCUMULATED SUM,
C NO OF STAGES, STAGE LENGTHS, ENTRANCE POWER, MIDPOINT POWER,
C EXIT POWER)
SUBROUTINE POWER3(Q,A2,MN,OLL,P0,P1,P2)
DIMENSION A2(100),Q(100),OLL(100), P0(100),
1P1(100),P2(100)
EQUIVALENCE (DELTA,FACNRM),(SIGMA,MSTPRT),(DELTA,ADUM)
SIGMA=0.
DELTA=0.
10 DO 50 I=1,MN
DELTA=DELTA+OLL(I)
A2(I)=(OLL(I)/6.)*(P0(I) 4.*P1(I)+P2(I))
SIGMA=SIGMA+A2(I)
C 50 CALCULATES TRAILING EDGE TO AVERAGE
50 Q(I)=P2(I)*OLL(I)/A2(I)
160 DO 190 I=1,MN
ADUM=A2(I)/SIGMA
IF(I 1)170,170,180
170 A2(I)=ADUM
GO TO 190
180 A2(I)=ADUM+A2(I-1)
190 CONTINUE
395 RETURN
END(0,0,0)
* * * * *
*PRSFUN CALCULATES TOT PRES CORRESPONDING TO
* GIVEN FLOW AREA, WT. FLOW, TOT TEMP, MACH NO, AND GAS
FUNCTION PRSFUN(A,W,T,OM,GAS)
GAMA=GAM(T,GAS)
PRSFUN=(W/((OM*A))*SQRTF((R(GAS)*T/(32.17*GAMA)))
1*(1. OM**2*(GAMA-1.)/2.))*((GAMA+1.)/(GAMA-1.)))
RETURN
END(0,1,0)
* * * * *
*PSTAT FUNCTION TO CALCULATE STATIC PRESSURE
C COMPRESSIBLE FLOW STATIC PRESSURE
* USAGE PSTAT(TOT PRES,TOT TEMP,MACH NO,GAS SELECTOR(FP))
FUNCTION PSTAT(P,T,OM,GAS)
GAMA=GAM(T,GAS)
PSTAT=P/((1.+((GAMA-1.)/2.)*OM**2))*((GAMA/(GAMA-1.)))
RETURN
END(0,1,0)
* * * * *
CTPINSR A SR TO INSPECT THE FIRST RECORD ON TAPE 2
* IF DIP-DATA CARD, BACKSPACES TAPE 2
* IF NOT A DIP-DATA CARD, WILL OUTPUT ON TAPE 3

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*A ONE OR ZERO IN COL 1 INDICATES COMMENT CARD	4190 663
SUBROUTINE TPINSP	4191 663
DIMENSION REMAIN(11)	4192 663
READ INPUT TAPE 2,32000,TEST,(REMAIN(N),N=1,11)	4193 663
32000 FORMAT(1A6,11A6)	4194 663
B AMASK=770000000000	4195 663
B CMASK=170000000000	4196 663
B BMASK=760000000000	4197 663
B ATEST=TEST*AMASK	4198 663
*TEST FOR ZERO CONTROL	4199 663
B CTEST=ATEST*CMASK	4200 663
IF(CTEST)100,300,100	4201 663
*TEST FOR ONE CONTROL	4202 663
B 100 BTEST=ATEST*BMASK	4203 663
IF(BTEST)200,300,200	4204 663
*DIP-CARD	4205 663
200 BACKSPACE 2	4206 663
GO TO 400	4207 663
*COMMENT CARD	4208 663
300 WRITE OUTPUT TAPE 3,32000,TEST,(REMAIN(N),N=1,11)	4209 663
400 RETURN	4210 663
END(0,1,0)	4211 663
* * * * *	4212 663
*XPRNT SUBROUTINE TO PRINT INTEGER VAR.	4213 663
SUBROUTINE XPRNT(B,V,J,N,K)	4214 663
DIMENSION V(500)	4215 663
IF(K)5,5,10	4216 663
5 IF(SENSE SWITCH 5)10,20	4217 663
10 WRITE OUTPUT TAPE 3,1000,B,J,(V(K),K=1,N)	4218 663
1000 FORMAT(6H0 A6,I3/(7I10))	4219 663
20 RETURN	4220 663
END(0,0,0)	4221 663

*STHA -THIS PROGRAM IS A MODIFICATION OF THE IBM 709
COUNT 700
*FORTRAN STH ROUTINE. IT IS ESSENTIALLY A MODICATION
*OF J. A. DELANEY 704 STHA USING 709 STH. PROGRAM
*MODIFICATIONS BY R.A. PASTORE NOV. 1960.

```

      REM
      REM
      ENTRY (STH)
      ENTRY (STHM)
      ENTRY RESTO
      ENTRY LINES
      ENTRY PAGES
      ENTRY NEWSET
      ENTRY HDING
      ENTRY NOHEAD
      ENTRY COLUMN
      ENTRY BOTTOM
      ENTRY ANPIPM
      ENTRY NOPAGE
      REM
      REM
      REM
      REM
      REM
      STHA TTR STH1
      IND72 PZE
      HDP PZE 1
      NP PZE ,0,1
      HDN PZE
      CHHD PZE
      D52 PZE ,0,53
      D53 PZE ,0,54
      D54 PZE ,0,55
      BINHD OCT 376060606060
      BCD 1
      REP 1,19
      STH1 CLA D(2)
      STO BOTLS
      CAL TIP8
      SLW ANPIPM
      STH18 CAL TOSTH
      SLW STH1
      STZ NLLFT
      STZ HDC
      STHB CLA 1,4
      STA WRBF1
      STA WRBF2-1
      STA GET1+1
      STA BUFNW
      STD NWDS
      SXD X4,4
      SXD X2,2
      SXD X1,1

```

ZERO FOR NO PAGE PRINTOUT

NEXT PAGE HEADING IND
CHANGE HEADING INDICATOR

BUFFER ADDRESS,0,WORD COUNT
INITIALIZE
WRRF ROUTINE

239

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      STHA 1
      STHA 2
      STHA 3
      STHA 4
      STHA 5
      STHA 6
      STHA 7
      STHA 8
      STHA 9
      STHA 10
      STHA 11
      STHA 12
      STHA 13
      STHA 14
      STHA 15
      STHA 16
      STHA 17
      STHA 18
      STHA 19
      STHA 20
      STHA 21
      STHA 22
      STHA 23
      STHA 24
      STHA 25
      036 STHA 26
      037 STHA 27
      038 STHA 28
      039 STHA 29
      040 STHA 30
      041 STHA 31
      042 STHA 32
      043 STHA 33
      044 STHA 34
      045 STHA 35
      046 STHA 36
      STHA 37
      STHA 38
      061 STHA 39
      STHA 40
      063 STHA 41
      064 STHA 42
      065 STHA 43
      066 STHA 44
      STHA 45
      068 STHA 46
      069 STHA 47
      070 STHA 48
      STHA 49
      071 STHA 50
      075 STHA 51
      076 STHA 52
      077 STHA 53

```

```

GET1  PXD    ,0
      LDQ
      LGL 6
      PAX ,2
      STO CONT
      SUB D(48)
      TZE PBL
      ADD D(32)
      TZE PPL
      TXH ILLGL,2,8
      TRA SET,2
PBL   LXA D(3),2
      TRA PNUM
OUT   LXD X1,1
      LXD X2,2
      LXD X4,4
BACK  TRA 2,4
*P1   PROCESS CONTROL 1
P1    CLA BOTLS
      TZE *+3
      STZ BOTLS
      TRA P1.2
      CLA HDC
      TZE P1.2
      TSX WRHD,4
      PZE
P1.2  TSX HDTST,4
      CLA R
      TZE P1.3
      LXA D(3),2
      STZ R
P1.3  TSX WRBF1,4
      TRA OUT
*PPL  PROCESS PLUS
PPL   LXA D(5),2
      TSX WRBF2,4
      TRA OUT
*P8   PROCESS CONTROL 8
P8    CLA NLLFT
      TZE P8.5
      CLA HDC
      TZE P8N
      LXD NLLFT,1
      TXL IS1,1,2
      TXI *+1,1,-2
      TSX WR1WD,4
      PZE 1
      TIX *-2,1,2
IS1   TXL   WR81,1,1
      TSX WR1WD,4
D(0)  PZE
WR81  LXA   D(3),2
      TSX WRBF1,4
P8.7  STZ NLLFT
      CLA LPP
      STO NL
      TRA OUT

```

```

WRITE HEADING
AT BOTTOM IF
CALLED FOR
TEST FOR HEADING
IS PAGE RESTORED
NO
MAKE CONTROL BLANK FOR YES

```

NUMBER OF LINES LEFT TO A

```

      STHA 54
079  STHA 55
080  STHA 56
081  STHA 57
082  STHA 58
083  STHA 59
084  STHA 60
085  STHA 61
086  STHA 62
087  STHA 63
088  STHA 64
089  STHA 65
090  STHA 66
091  STHA 67
092  STHA 68
093  STHA 69
095  STHA 70
096  STHA 71
097  STHA 72
098  STHA 73
099  STHA 74
100  STHA 75
101  STHA 76
102  STHA 77
103  STHA 78
104  STHA 79
105  STHA 80
106  STHA 81
107  STHA 82
108  STHA 83
109  STHA 84
110  STHA 85
111  STHA 86
112  STHA 87
113  STHA 88
114  STHA 89
115  STHA 90
116  STHA 91
117  STHA 92
118  STHA 93
119  STHA 94
120  STHA 95
121  STHA 96
122  STHA 97
123  STHA 98
124  STHA 99
125  STHA 100
126  STHA 101
      STHA 102
128  STHA 103
129  STHA 104
      STHA 105
131  STHA 106
132  STHA 107
133  STHA 108
134  STHA 109
135  STHA 110

```

REM			STHA 111
REM	WRITE 1 WORD ROUTINE.		STHA 112
REM	TSX WR1WD,4		STHA 113
REM	PZE N		STHA 114
REM	WHERE N = 0,1,2 FOR BLANK,ZERO,OR FOUR.		STHA 115
REM			STHA 116
WR2	PZE 1WD		STHA 117
WR1WD	CLA WR2		STHA 118
	SUB 1,4		STHA 119
	STA *+2		STHA 120
	SXA WR3,4		STHA 121
	TSX WRITE,4		STHA 122
	PZE ,0,1		STHA 123
WR3	AXT ,4		STHA 124
	TRA 2,4		STHA 125
P8N	TSX WRBF2,4	142	STHA 126
	TRA P8.7	143	STHA 127
P8.5	LXA D(1),2	144	STHA 128
	TRA P1	145	STHA 129
*ELFT	ENOUGH LINES LEFT	146	STHA 130
*TRA1,4	FOR NO	147	STHA 131
*TRA2,4	FOR YES	148	STHA 132
*CALL		149	STHA 133
*	TSX ELFT,4	150	STHA 134
ELFT	CAL VECT,2	151	STHA 135
	ANA DMSK	152	STHA 136
	CAS NLLFT	153	STHA 137
	TRA 1,4	154	STHA 138
	TRA 2,4	155	STHA 139
	TRA 2,4	156	STHA 140
*WRHD	WRITE TH CURRENT HEADING	157	STHA 141
*CALL		158	STHA 142
*	TSX WRHD,4	159	STHA 143
*	ZER 0 OR 1	160	STHA 144
WRHD	SXD WSV1,1	161	STHA 145
	SXD WSV4,4	162	STHA 146
	CLA BINHD	163	STHA 147
	STO SBNHD	164	STHA 148
	CLA TOPHD	165	STHA 149
	STO BINHD	166	STHA 150
	SXD WSV2,2	167	STHA 151
	CLA 1,4	168	STHA 152
	PAX ,1	169	STHA 153
ADRHD	CAL A	170	STHA 154
	ANA MSK	171	STHA 155
	ORA M8,1	172	STHA 156
ADHD	SLW A	173	STHA 157
	LXA D(20),1	174	STHA 158
	CLA IND72	175	STHA 159
	TNZ *+2	176	STHA 160
	TXI *+1,1,-8	177	STHA 161
	CLA 1,4	178	STHA 162
	TZE NPG	179	STHA 163
	CLA HDP	180	STHA 164
	TZE NPG	181	STHA 165
	TSX OTOD,4	182	STHA 166
	TRA LCPYLP	183	STHA 167

GET NUMBER OF LINES
ENOUGH

BOT OR TOP

1ST WORD OF HEADING

INSERT 1 OR 8

IS PRINT 72 COL

YES REDUCE WORDS BY 8

GET CONTROL IS THIS TOP

NO

YES TEST FOR PRINTING PAGE

NO

YES GET BCI PAGE

241- 3.12

NPG	TRA	WR4-3		STHA	168
CPYLP	LXA	D(2),2		STHA	169
	PXA	,1		STHA	170
	ADD	ADHD		STHA	171
	STA	HDSAV1		STHA	172
	STA	HDSAV2		STHA	173
	STA	HDSAV4		STHA	174
HDSAV1	CLA	,2	SAVE	STHA	175
	STO	HDSAV+2,2	LAST 2	STHA	176
	CLA	PAGEN+2,2	WORDS OF	STHA	177
HDSAV2	STO	,2	HEADING	STHA	178
	TIX	*-4,2,1		STHA	179
	CLA	*+1		STHA	180
	STO	HDSAV+2		STHA	181
	SXD	WR4+1,1		STHA	182
	CLA	ADHD		STHA	183
	STA	WR4+1		STHA	184
WR4	TSX	WRITE,4		STHA	185
	PZE	,,--		STHA	186
	NZT	HDSAV+2	WAS HEAD SAVED.	STHA	187
	TRA	HDSAV3	NO.	STHA	188
	STZ	HDSAV+2	YES. RESTORE	STHA	189
	LXA	D(2),2	LAST 2 WORDS	STHA	190
	CLA	HDSAV+2,2	OF HEADING	STHA	191
HDSAV4	STO	,2		STHA	192
	TIX	*-2,2,1		STHA	193
HDSAV3	LXD	WSV1,1		STHA	194
	CLA	SBNHD		197	STHA 195
	STO	BINH		198	STHA 196
	LXD	WSV2,2		199	STHA 197
	LXD	WSV4,4		200	STHA 198
	TRA	2,4		201	STHA 199
SV1	PZE			202	STHA 200
SV2	PZE			203	STHA 201
SV4	PZE			204	STHA 202
BNHD	PZE			205	STHA 203
HDSAV	BSS	2			STHA 204
	PZE	0			STHA 205
*HDTST	TEST FOR PRINTING HEADING			206	STHA 206
*TESTS	IF HEADING SPECIFICATION HAS BEEN			207	STHA 207
*CHANGED	IF SO WHETHER IT HAS BEEN			208	STHA 208
*CANCELLED	IF NOT IT WRITES THE HEADING			209	STHA 209
*RETURNS	HDC =0 FOR NO HEADING HDC=1 FOR ONE			210	STHA 210
*SETS	NL TO ZERO ANP UPDATES NP			211	STHA 211
*ENTER	BY			212	STHA 212
*	TSX HDTST,4			213	STHA 213
*	NORMAL RETURN			214	STHA 214
HDTST	STZ	R		215	STHA 215
	STZ	BOTLS		216	STHA 216
	CLA	MBHD	HAS BINARY BUFFER BEEN	217	STHA 217
	CAS	BINH	CHANGED	218	STHA 218
	TRA	SETB	YES	219	STHA 219
	CLA	CHHD	NO HAS CALL HDING BEEN USED	220	STHA 220
	TNZ	SETC	YES	221	STHA 221
	CLA	HDN	NO HAS CALL NOHEAD BEEN USED	222	STHA 222
	TNZ	DONE1		223	STHA 223
STZH	STZ	HDC		224	STHA 224

	CLA HDP		225	STHA	225
	TNZ WOPG		226	STHA	226
STZH1	CLA D54		227	STHA	227
	STZ HDN		228	STHA	228
	TRA SLPP		229	STHA	229
LBHD1	PZE BINHD		230	STHA	230
SETB	CAL BINHD	SET UP TO PRINT HEADING	231	STHA	231
	SLW TOPHD	1 IN COL 1	232	STHA	232
	CLA LBHD1		233	STHA	233
	STA ADHD		234	STHA	234
	STA ADRHD		235	STHA	235
	CLA MBHD	RESTORE 1ST WORD	236	STHA	236
	STO BINHD	OF BINARY BUFFER	237	STHA	237
	TRA DONE1			STHA	238
SETC	STZ CHHD		239	STHA	239
DONE1	SXD SV4,4		240	STHA	240
	TSX WRHD,4		241	STHA	241
D(1)	PZE 1		242	STHA	242
	LXD SV4,4		243	STHA	243
	CLA D52		244	STHA	244
	STO HDC		245	STHA	245
	STO HDN		246	STHA	246
SR	STO R		247	STHA	247
SLPP	STO LPP		248	STHA	248
	STO NLLFT		249	STHA	249
	CLA NP		250	STHA	250
	ADD D1		251	STHA	251
	STO NP		252	STHA	252
	STZ NL		253	STHA	253
	CLA R		254	STHA	254
	TNZ *+6		255	STHA	255
	CLA D19		256	STHA	256
	STO VECT2		257	STHA	257
	CLA D7		258	STHA	258
	STO VECT4		259	STHA	259
	TRA 1,4		260	STHA	260
	CLA D18		261	STHA	261
	STO VECT2		262	STHA	262
	CLA D6		263	STHA	263
	STO VECT4		264	STHA	264
	TRA 1,4		265	STHA	265
SV4	PZE		266	STHA	266
WOPG	LXA D(17),1		267	STHA	267
	SXD WOPG4,4		268	STHA	268
	TSX OTOD,4	GET PAGE IN BCI	269	STHA	269
	CLA IND72		270	STHA	270
	TNZ *+2	HDTST	271	STHA	271
	TXI *+1,1,-8		272	STHA	272
	SXA WR5,1			STHA	273
	PXA ,1			STHA	274
	ADD RECRD			STHA	275
	ADD D(1)			STHA	276
	STA WR6			STHA	277
	LXA D(20),2	SAVE		STHA	278
	CLA REC+20,2	RECORD		STHA	279
	STO SVREC+20,2	BUFFER		STHA	280
	TIX *-2,2,1			STHA	281

	CLA	15BLK		STHA	282
	STO	REC		STHA	283
	CLA	ALBLK		STHA	284
WR6	STO	,1		STHA	285
	TIX	*-1,1,1		STHA	286
WR5	AXT	,1		STHA	287
	LXA	D(2),2		STHA	288
	PXA	,1		STHA	289
	ADD	D(3)		STHA	290
	PAX	,1		STHA	291
	PXA	,1		STHA	292
	ADD	RECRD		STHA	293
	STA	*+2		STHA	294
	CLA	PAGEN+2,2		STHA	295
	STO	,2		STHA	296
	TIX	*-2,2,1		STHA	297
	SXD	WR7+1,1		STHA	298
	CLA	RECRD		STHA	299
	STA	WR7+1		STHA	300
WR7	TSX	WRITE,4		STHA	301
	PZE	,,--		STHA	302
	LXA	D(20),2	RESTORE	STHA	303
	CLA	SVREC+20,2	RECORD	STHA	304
	STO	REC+20,2	BUFFER	STHA	305
	TIX	*-2,2,1		STHA	306
	CLA	D53		280	STHA 307
	STZ	HDC		281	STHA 308
	STZ	HDN		282	STHA 309
	LXD	WOPG4,4		283	STHA 310
	TRA	SR		284	STHA 311
WOPG4	PZE			285	STHA 312
	SVREC	BSS 20			STHA 313
	*WRBF WRITE BUFFER ON TAPE			286	STHA 314
	*ADDRESSES ARE STORED BY STH ETC.			287	STHA 315
WRBF1	CAL	BUF		288	STHA 316
	ANA	MSK		289	STHA 317
	ORA	M0,2		290	STHA 318
	SLW	BUF		291	STHA 319
WRBF2	SXD	W4,4		292	STHA 320
	CLA	NWDS			STHA 321
	STD	WR8+1			STHA 322
	CLA	BUFNW			STHA 323
	STA	WR8+1			STHA 324
WR8	TSX	WRITE,4			STHA 325
	PZE	,0,--			STHA 326
	LXD	W4,4		298	STHA 327
	CAL	VECT,2		299	STHA 328
	ADD	NL		300	STHA 329
	STD	NL		301	STHA 330
	CLA	LPP		302	STHA 331
	SUB	NL		303	STHA 332
	STD	NLLFT		304	STHA 333
	CAL	VECT2		305	STHA 334
	SUB	VECT,2		306	STHA 335
	TZE	*+2		307	STHA 336
	TPL	*+2		308	STHA 337
	ADD	D18		309	STHA 338

	STO VECT2		310	STHA	339
	SUB D6		311	STHA	340
	TZE *+2		312	STHA	341
	TPL *-2		313	STHA	342
	ADD D6		314	STHA	343
	STO VECT4		315	STHA	344
	TRA 1,4		316	STHA	345
W4	PZE		317	STHA	346
*PNUM	PROCESS BLANK, 2, 4, 0,		318	STHA	347
PNUM	STZ R	0 TO RESTORE INDICATOR	319	STHA	348
	TSX ELFT,4	TEST IF LINES LEFT	320	STHA	349
	TRA NOT	NO	321	STHA	350
	TSX WRBF2,4	YES WRITE BUFFER	322	STHA	351
	TRA OUT		323	STHA	352
NOT	LXA D(1),2	REPLACE COL 1 BY 1	324	STHA	353
	TRA P1		325	STHA	354
*ILLGL	PROCESS ILLEGAL CHARACTER		326	STHA	355
TOILG	TRA NILL1+1		327	STHA	356
ILLGL	CLA TOILG		328	STHA	357
	STO BACK		329	STHA	358
	LXA D(6),2		330	STHA	359
	TSX ELFT,4	4LINES LEFT	331	STHA	360
	TRA NILL	NO	332	STHA	361
	LXA D(0),2	YES	333	STHA	362
NILL1	TSX WRBF1,4	WRITE LINE WITH BLANK	334	STHA	363
	CAL ILMK		335	STHA	364
	ANS ILCH+3		336	STHA	365
	CAL CONT		337	STHA	366
	ALS 12	ILLGL	338	STHA	367
	ORS ILCH+3		339	STHA	368
	CLA ELFT+4		340	STHA	369
	STO BACK		341	STHA	370
	LXD X4,4		342	STHA	371
	SXD XX4,4		343	STHA	372
	LXD X2,2		344	STHA	373
	LXD X1,1		345	STHA	374
	TSX STHB,4			STHA	375
LILCH	PZE ILCH,0,10		347	STHA	376
	LXD XX4,4		348	STHA	377
	TRA 2,4		349	STHA	378
XX4	PZE		350	STHA	379
NILL	LXA D(1),2		351	STHA	380
	TRA P1		352	STHA	381
*OTOD	OCTAL TO DECIMAL INTEGER		353	STHA	382
*SETS	UP 2 WORDS OF BCI * PAGE XXXX *		354	STHA	383
*CALL			355	STHA	384
*	TSX OTOD,4		356	STHA	385
OTOD	SXD OS4,4		357	STHA	386
	CLA 50BLK		358	STHA	387
	STO PGN		359	STHA	388
	LXA D(30),4		360	STHA	389
	CLA NP		361	STHA	390
	ARS 18		362	STHA	391
	LRS 35	NP TO MQ	363	STHA	392
DV10	DVP D(10)	N(1)/10	364	STHA	393
	ALS 36,4	SHIFT REMAINDER	365	STHA	394
	IXI *+1,4,-6	245	366	STHA	395

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      ORS PGN
      STQ T
      CLA T
      TZE INSB
      PXD
      TRA DV10
INSB  LDQ PGN
      LXA D(5),4
      PXD
      LGL 6
      TNZ *+2
      TIX *-2,4,1
      TXI *+1,4,-1
      CAL PGNM,4
      ORS PGN
      LXD OS4,4
      TRA 1,4
      PZE
      BCD 1 00000
      BCD 1 0000
      BCD 1 000
PGNM  BCD 1 00
OS4   PZE
T     PZE
*RESTO PAPER WILL BE RESTORED BEFORE
*NEXT LINE IS WRITTEN
*USAGE
*      CALL RESTO
RESTO  SXD X4,4
      TRA BOT.2
*PAGES RETURNS THE CURRENT PAGE NUMBER
*USAGE
*      CALL PAGES(NP) CURRENT PAGE NO TO NP
*PAGES AND LINES
PAGES  CLA 1,4
      STA *+3
      CLA NP
      SUB D1
      STO
      TRA 2,4
*LINES RETURNS THE NUMBER OF LINES
*PRINTED SO FAR ON THE CURRENT PAGE
*USAGE
*      CALL LINES(NL) NO. OF LINES TO NL
LINES  CLA 1,4
      STA *+2
      CLA NL
      STO
      TRA 2,4
*NEWSET RESETS PAGE NUMBER TO ARGUMENT(NP)
*AND SETS INDICATOR TO PRINT PAGE NUMBER
*USAGE
*      CALL NEWSET(NP) NEXT PAGE WILL BE NP
NEWSET CLA 1,4
      STO HDP
      STA *+1
      CLA

```

MASK INTO PGN

0 LEADING BLANKS

1	*	*
2	*	*
3	*	*
4	*	*

THESE
MUST BE
IN THIS
IDENTICAL
ORDER

```

367 STHA 396
368 STHA 397
369 STHA 398
370 STHA 399
371 STHA 400
372 STHA 401
373 STHA 402
374 STHA 403
375 STHA 404
376 STHA 405
377 STHA 406
378 STHA 407
379 STHA 408
380 STHA 409
381 STHA 410
382 STHA 411
383 STHA 412
384 STHA 413
385 STHA 414
386 STHA 415
387 STHA 416
388 STHA 417
389 STHA 418
390 STHA 419
391 STHA 420
392 STHA 421
393 STHA 422
394 STHA 423
395 STHA 424
396 STHA 425
397 STHA 426
398 STHA 427
399 STHA 428
400 STHA 429
      STHA 430
402 STHA 431
403 STHA 432
404 STHA 433
405 STHA 434
406 STHA 435
407 STHA 436
408 STHA 437
409 STHA 438
410 STHA 439
      STHA 440
412 STHA 441
413 STHA 442
414 STHA 443
415 STHA 444
416 STHA 445
417 STHA 446
418 STHA 447
419 STHA 448
      STHA 449
421 STHA 450
422 STHA 451
423 STHA 452

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        SSP
        STO NP
        TRA 2,4
*HDING INITIALIZES STH TO WRITE
*SPECIFIED HEADING SETS CHHD=1
*USAGE
*   CALL HDING(A)   WHERE A IS THE INITIAL
*                   LOCATION OF 120 BCI CHARACTERS
*OR   CALL HDING(120H ...HEADING...)
*HDING PROCESS CALL HDING(A)
*INITIALIZES FOR HEADING COPY LOOP
HDING  CLA 1,4
        STA ADHD
        STA ADRHD
        CLA MBHD
        STO CHHD
        STO BINHD
        TRA 2,4
*COLUMN INITIALIZES PRINTOUT OF PAGE
*NUMBER FOR 72 OR 120 COLUMN PRINTOUT
*IF NOT SPECIFIED 120 IS ASSUMED
*USAGE
*   CALL COLUMN(N)   N=72 FOR 72COL.
*                   N NOT =72 FOR 120
COLUMN CLA 1,4
        STA *+1
        CLA
        SUB D72
        STO IND72
        TRA 2,4
*NOPAGE INIALIZES STH TO OMIT WRITING
*PAGE NUMBER
*USAGE
*   CALL NOPAGE
NOPAGE STZ HDP
        TRA 1,4
*NOHEAD INITIALIZES STH TO OMIT WRITING
*HEADING BEGINNING WITH NEXT PAGE
*USAGE
*   CALL NOHEAD
NOHEAD STZ CHHD
        STZ HDN
        CLA MBHD
        STO BINHD
        TRA 1,4
*BOTTOM PRINTS HEADING IF THERE IS
*ONE AT BOTTOM OF PAGE AND SETS LINE CTR
*USAGE
*   CALL BOTTOM
*BOTTOM WRITES HEADING AT BOTTOM
BOTTOM SXD X4,4
        CLA BOTLS
        TNZ BOT.2
        SXD BOTLS,4
        CLA HDC
        TZE BOT.1
        TSX WRHD,4

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424 STHA 453
425 STHA 454
426 STHA 455
427 STHA 456
428 STHA 457
429 STHA 458
430 STHA 459
431 STHA 460
432 STHA 461
433 STHA 462
434 STHA 463
435 STHA 464
436 STHA 465
437 STHA 466
438 STHA 467
439 STHA 468
440 STHA 469
441 STHA 470
442 STHA 471
443 STHA 472
444 STHA 473
445 STHA 474
446 STHA 475
447 STHA 476
      STHA 477
449 STHA 478
450 STHA 479
451 STHA 480
452 STHA 481
453 STHA 482
454 STHA 483
455 STHA 484
456 STHA 485
457 STHA 486
      STHA 487
459 STHA 488
460 STHA 489
461 STHA 490
462 STHA 491
463 STHA 492
      STHA 493
465 STHA 494
466 STHA 495
467 STHA 496
468 STHA 497
469 STHA 498
470 STHA 499
471 STHA 500
472 STHA 501
473 STHA 502
      STHA 503
475 STHA 504
476 STHA 505
477 STHA 506
478 STHA 507
479 STHA 508
480 STHA 509

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BOT.2	PZE		481	STHA	510
	STZ NLLFT		482	STHA	511
	CLA LPP		483	STHA	512
	STO NL		484	STHA	513
	LXD X4,4		485	STHA	514
	TRA 1,4		486	STHA	515
BOT.1	CLA NLLFT		487	STHA	516
	TZE BOT.2+1		488	STHA	517
	CLA 85BLK			STHA	518
	STO REC			STHA	519
	TSX WRITE,4			STHA	520
	PZE REC,,1			STHA	521
	TRA BOT.2		492	STHA	522
85BLK	BCD 18		493	STHA	523
*IPM AND FPM			494	STHA	524
ANPIP	CAL TSIP8			STHA	525
	SLW STH1		501	STHA	526
IPMP8	CLA 1,4		502	STHA	527
	SXD PMSV4,4		503	STHA	528
	TNZ FPM		504	STHA	529
	CLA STH1		505	STHA	530
	STO SVSH1		506	STHA	531
	CLA TOPM1		507	STHA	532
	STO STH1		508	STHA	533
	TSX BOTTOM,4			STHA	534
	CLA 15BLK			STHA	535
	STO REC			STHA	536
	TSX WRITE,4			STHA	537
	PZE REC,0,1			STHA	538
	LXD PMSV4,4		513	STHA	539
	TRA 2,4		514	STHA	540
TOPM2	TTR PM2		515	STHA	541
PMSV4	PZE		516	STHA	542
TOPM1	TTR PM1		517	STHA	543
SVSH1	PZE	ORIGINAL STH1	518	STHA	544
PM1	CLA 1,4		519	STHA	545
	STA *+5		520	STHA	546
	STA *+1		521	STHA	547
	CAL		522	STHA	548
	ANA MSK		523	STHA	549
	ORA MBL		524	STHA	550
	SLW		525	STHA	551
	CLA TOPM2		526	STHA	552
	STO STH1		527	STHA	553
PM2	CLA 1,4			STHA	554
	STO WR9+1			STHA	555
	SXD X4,4				
WR9	TSX WRITE,4			STHA	556
	PZE ,,-			STHA	557
	LXD X4,4				
	TRA 2,4				
FPM	CLA SVSH1	RESTORE ORINAL	540	STHA	558
	STO STH1	STH1	541	STHA	559
	TRA 2,4		542	STHA	560
*LOCATION SYMBOLS			543	STHA	561
NL	PZE	NUMBER OF LINES PRINTED	544	STHA	562
R	PZE	RESTORE INDICATOR	545	STHA	563

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HDC	PZE	CURRENT HEADING INDICATOR	246	STHA	204
NLLFT	PZE	LINES LEFT	547	STHA	565
BOTHD	PZE		548	STHA	566
TOPHD	PZE		549	STHA	567
PAGEN	BCD 1 PAGE		550	STHA	568
PGN	PZE	PAGE NUMBER IN DECIMAL	551	STHA	569
LPP	PZE	LINES PER PAGE	552	STHA	570
15BLK	BCD 11		553	STHA	571
50BLK	BCD 100000		554	STHA	572
*MASKS	FOR ADDINING CONTROL CHARACTER		555	STHA	573
MSK	OCT 007777777777		556	STHA	574
MBHD	OCT 376060606060		557	STHA	575
ALBLK	BCD 1		558	STHA	576
Z5BLK	BCD 10		559	STHA	577
DMSK	OCT 077777000000		560	STHA	578
ILMSK	OCT 377777007777		561	STHA	579
	BCD 1100000		562	STHA	580
M8	BCD 1800000		563	STHA	581
	PZE		564	STHA	582
	PZE		565	STHA	583
M4	BCD 1400000		566	STHA	584
MBL	BCD 1 00000	BLANK	567	STHA	585
M2	BCD 1200000		568	STHA	586
M1	BCD 1100000		569	STHA	587
M0	BCD 1000000		570	STHA	588
NWDS	PZE	NUMBER OF WORDS	576	STHA	589
BUF	PZE	ADDRESS FOR COPY LOOP	577	STHA	590
1STWD	PZE	1ST WORD OF OUTPUT	578	STHA	591
X4	PZE	ORIGINAL C(4)	575	STHA	592
X2	PZE	ORIGINAL C(2)	579	STHA	593
X1	PZE	ORIGINAL C(1)	580	STHA	594
CONT	PZE	CONTROL FROM PROGRAM	581	STHA	595
ILCH	BCD 50CONTROL CHARACTER * C * OF PR		582	STHA	596
	BCD 5ECEDING LINE IS NOT LEGAL		583	STHA	597
	TXL P8	8	584	STHA	598
	TXL ILLGL	7	585	STHA	599
	TXL ILLGL,0,0	5 LATER PLUS	587	STHA	600
	TXL ILLGL,0,4	6 STAYS ILLGL	586	STHA	601
	TXL PNUM,0,6	4	588	STHA	602
	TXL ILLGL,0,1	3 LATER BLANK	589	STHA	603
	TXL PNUM,0,18	2	590	STHA	604
	TXL P1,0,1	1	591	STHA	605
SET	TXL PNUM,0,2	0	592	STHA	606
	BCD 14	6 LINES	593	STHA	607
	BCD 10	2 LINES	594	STHA	608
1WD	BCD 1	1 LINE	595	STHA	609
*CONSTANTS	IN ADDRESS PORTION		596	STHA	610
D(2)	PZE 2		597	STHA	611
D(3)	PZE 3		598	STHA	612
D(5)	PZE 5		599	STHA	613
D(6)	PZE 6		600	STHA	614
D(10)	PZE 10		601	STHA	615
D(17)	PZE 17		602	STHA	616
D(19)	PZE 19		603	STHA	617
D(20)	PZE 20		604	STHA	618
D(24)	PZE 24		605	STHA	619
D(30)	PZE 30		606	STHA	620

D(32)	PZE	32		607	STHA	621
D(36)	PZE	36		608	STHA	622
D(48)	PZE	48		609	STHA	623
D(52)	PZE	52		610	STHA	624
*CONSTANTS IN DECREMENT				611	STHA	625
D1	PZE	,0,1		612	STHA	626
D5	PZE	,0,5		613	STHA	627
D6	PZE	,0,6		614	STHA	628
D7	PZE	,0,7		615	STHA	629
D17	PZE	,0,17		616	STHA	630
D18	PZE	,0,18		617	STHA	631
D19	PZE	,0,19		618	STHA	632
D72	PZE	,0,72		619	STHA	633
TIP8	TTR	IPMP8		621	STHA	634
TS1P8	TTR	STH18		622	STHA	635
TOSTH	TTR	STHB			STHA	636
*NEW VECTOR FOR LINES REQUIRED				623	STHA	637
VECT6	PZE	,0,4	4 LINES FOR ILLEGAL CHAR.	624	STHA	638
VECT5	PZE	,0,0	0 LINES FOR +	625	STHA	639
VECT4	PZE		VARIABLE NUMBER FOR 4	626	STHA	640
VECT3	PZE	,0,1	1 LINE FOR BLANK	627	STHA	641
VECT2	PZE		VARIABLE NUMBER FOR 2	628	STHA	642
VECT1	PZE	,0,1	1 LINE FOR RESTORE	629	STHA	643
VECT	PZE	,0,2	2 LINES FOR 0	630	STHA	644
SVV4	PZE			632	STHA	645
BOTLS	PZE		NON-ZERO IF BOT. HD WAS LAST	633	STHA	646
1	PZE	0			STHA	647
BUFNW	PZE	0			STHA	648
	REM				STHA	649
	REM		THIS ROUTINE WRITES AN N WORD		STHA	650
	REM		RECORD STARTING AT LOCATION M.		STHA	651
	REM	TSX	WRITE,4		STHA	652
	REM	PZE	M,0,N		STHA	653
	REM				STHA	654
WRITE	CLA	1,4	BUFFER ADDRESS,0,NO. OF WORDS.		STHA	655
	STO	WR+1			STHA	656
	STA	REC1			STHA	657
	SXA	WR1,4	SAVE IR4.		STHA	658
WR	TSX	STHW,4			STHA	659
	PZE	,0,--			STHA	660
WR1	AXT	,4			STHA	661
	CLA	RECRD	RESTORE REC IN ADDRESS.		STHA	662
	STA	REC1			STHA	663
	TRA	2,4	OUT.		STHA	664
RECRD	PZE	REC			STHA	665
	REM				STHA	666
(STH)	LDQ	*+2	PICKUP SWITCH SETTING, AND		STHA	667
	TRA*	\$(IOH)	GO INITIALIZE (IOH).		STHA	668
	TRA	STH	OUTPUT / STORAGE TO TAPE HOLLERITH.		STHA	669
(STHM)	LDQ	*+2	PICKUP SWITCH SETTING, AND		STHA	670
	TRA*	(IOH)	GO INITIALIZE IOH.		STHA	671
	TRA	STHM	OUTPUT / TAPE MONITOR.		STHA	672
	REM				STHA	673
STHM	CAL	37	INCREASE		STHA	674
	ADM	TES+2	LINE COUNT		STHA	675
	STA	37	BY 1.		STHA	676
	REM				STHA	677

STH	TTR	STHA		STHA 671
STHW	SXA	STHX,4	SAVE RETURN INDEX.	STHA 671
TES	TSX	\$(WER),4	GO CHECK PREVIOUS WRITE.	STHA 681
	LXA	STHX,4		STHA 681
	CAL	1,4	SET WORD COUNT	STHA 681
	STD	STHC	OF WRITE COMMAND.	STHA 681
	AXT	0,4		STHA 681
	SXA	*+6,2	MOVE	STHA 681
	PDX	,2	RECORD	STHA 681
REC1	CAL	REC,4	INTO	STHA 681
	SLW	OUTPUT,4	OUTPUT	STHA 681
	TXI	*+1,4,-1	BUFFER.	STHA 681
	TIX	*-3,2,1		STHA 690
	AXT	,2		STHA 691
	CAL	TES	SET SWITCH FOR	STHA 692
	SLW*	\$(TES)	WRITE OVERLAP.	STHA 692
	XEC*	\$(WRS)	SELECT CURRENT UNIT.	STHA 692
	AXC	STHC,4	INITIALIZE	STHA 692
	PXA	,4	FOR	STHA 692
	STA*	\$(WTC)	WRITE CHECKING.	STHA 692
	XEC*	\$(RCH)	WRITE ONE TAPE RECORD.	STHA 692
STHX	AXT	,4	RESTORE RETURN INDEX.	STHA 692
	TRA	2,4	EXIT TO IOH.	STHA 700
	REM			STHA 701
	REM			STHA 702
STHC	IOST	OUTPUT,9--	WRITE COMMAND	STHA 702
OUTPUT	BSS	20	OUTPUT BUFFER	STHA 704
	COMMON	-205+20	WAS 206	STHA 705
REC	COMMON	1	RECORD BUFFER	STHA 706
	REM			STHA 707
	END			STHA 708

*WOT -- WRITE OUTPUT TAPE NOV 1960
COUNT 100
ENTRY WOT

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*
*      FORTRAN 2 LIBRARY SUBROUTINE WOT
*
*      WOT REQUIRES (LEV),(FIL),(STH), AND (SPH) TO BE IN THE
*
*      CALLING SEQUENCE
*
*      CALL WOT (N)
*
*
*      THE WOT SUBROUTINE WILL CONTROL ALL PRINT AND/OR
*      WRITE OUTPUT TAPE STATEMENTS IN THE PROGRAM WHICH
*      OCCUR LOGICALLY AFTER THE FIRST USE OF THE WOT
*      SUBROUTINE.  THE ARGUMENT USED WILL APPLY UNTIL
*      ANOTHER CALL WOT (N) STATEMENT IS USED TO CHANGE
*      THE ARGUMENT TO ANOTHER VALUE.  EITHER AN INTEGER
*      OR AN INTEGER VARIABLE MAY BE USED FOR THE
*      ARGUMENT THUS ALLOWING THE PROGRAMMER TO FIX THE
*      OUTPUT OR TO PLACE IT UNDER CONTROL OF AN INPUT
*      CODE WORD.

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* WITH A DIFFERENT INTEGER VARIABLE IN THE ARGUMENT
 * PRIOR TO EACH SET OF OUTPUT COMPLETE CONTROL OF
 * EACH SET OF OUTPUT MAY BE MADE A FUNCTION OF INPUT.
 * REGARDLESS OF WHETHER A PRINT OR A WRITE OUTPUT
 * TAPE STATEMENT WAS USED, OUTPUT WILL BE GIVEN ON
 * TAPE 3 AND/OR THE PRINTER ACCORDING TO THE
 * FOLLOWING SCHEME ---

ARGUMENT OF WOT	OUTPUT ON TAPE 3	PRINTER
1	YES	YES
2	YES	IF SW3 DOWN
3	YES	NO
4	IF SW3 UP	YES
5	IF SW3 UP	IF SW3 DOWN
6	IF SW3 UP	NO
7	NO	YES
8	NO	IF SW3 DOWN
9	NO	NO

WOT	CAL	TRWOTB	ENTRY FOR FIRST
	SLW*	\$(STH)	OCCURRENCE OF CALL WOT
	CAL	TRWTB1	
	SLW*	\$(SPH)	
	CAL	TRWOTA	SET TYPE ROUTINES TO
	SLW	WOT	BRING IN WOT
	CAL	\$(STH)	
	ADD	=3	INITIALIZE JUMPS
	STA	TRASH	FROM IOH
	CAL	\$(SPH)	
	ADD	FIVE	
	STA	TRASP	
WOTA	CLA*	1,4	ENTRY FOR SUCCEEDING
	ARS	18	CALL WOTS
	ADD	*+6	
	STA	*+1	LOOK UP IN TABLE AND
	CLA		SET TRIGGERS FOR
	STA	TCON	WRITE-PRINT OPTIONS
	STD	PCON	
	TRA	2,4	BACK TO MAIN
	HTR	*	
	PZE	2,0,2	ADDR.=1 WRITE IF SW3 UP
	PZE	2,0,1	ADDR.=2 WRITE
	PZE	2,0,3	ADDR.=3 DONT WRITE
	PZE	1,0,2	
	PZE	1,0,1	DECR.=1 PRINT IF SW3 DOWN
	DZE	1,0,2	DECR.=2 PRINT

	PZE	3,0,2	DECR.=3 DONT PRINT
	PZE	3,0,1	
	PZE	3,0,3	
WOTB1	CAL	DECR3	ENTRY FROM SPH
WOTB	SLW	UNIT	ENTRY FROM STH
	SXD	IX4,4	
	CLA	TCON	
	SUB	TWO	TEST WRITE TRIGGER
	TZE	WRITE	
	TPL	SKIPT	
	SWT	SWCH3	
	TRA	WRITE	
SKIPT	CLA	TWO	
	STO	SKCON	
	TRA	WOTD	GO TO TEST PRINT
WRITE	STZ	SKCON	
	CAL*	\$(FIL)	SET FIL TO BRING IN WOT
	SLW	CFIL	
	CAL	TRWOTC	
	SLW*	\$(FIL)	
	LDQ	TRASH	INITIALIZE FOR
	CAL	UNIT	WRITING AND
	TRA*	\$(IOH)	
WOTC	SXD	IN4,4	ENTRY FROM FIL
	CAL	CFIL	RESTORE FIL AND
	SLW*	\$(FIL)	GO BACK, BUT RETURN
	TSX	\$(FIL),4	WILL BE TO WOTD
WOTD	CLA	PCON	
	ARS	18	
	SUB	TWO	TEST PRINT TRIGGER
	TZE	PRINT	
	TPL	SKIPP	
	SWT	SWCH3	
	TRA	SKIPP	
PRINT	LXD	IX4,4	SET INDEX FOR RETURN
	LDQ	TRASP	TO FIRST INSTR AFTER
	CLA	DECR3	TSX TYPE. INITIALIZE
	TRA*	\$(IOH)	
SKIPP	CLA	SKCON	WE DIDNT PRINT
	TNZ	SKIPPD	DID WE WRITE
	LXD	IN4,4	YES RETURN TO FIRST
	TRA	1,4	INSTR AFTER TSX FIL
SKIPPD	LXD	IX4,4	
	CAL	2,4	NO FLIP THROUGH
	STA	*+1	AND LOOK FOR IT
	CLA		
	SUB	\$(FIL)	GO THERE
	TZE	EXIT	
	TXI	SKIPPD+1,4,-1	
EXIT	TRA	3,4	THEN TRANSFER
TRWOTA	TRA	WOTA	
TRWOTB	TRA	WOTB	
TRWTB1	TRA	WOTB1	
TRWOTC	TRA	WOTC	
TRASH	JRA		
TRASP	TRA		
TWO	DEC	2	

FIVE DEC 5
TCON PZE
PCON PZE
UNIT PZE
SKCON PZE
CFIL PZE
IN4 PZE
IX4 PZE
DECR3 MZE 993
SWCH3 EQU 3

END